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STATUS OF THE SNOWSHOE HARE ON THE CONNECTICUT HILL WILDLIFE MANAGEMENT AREA¹

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ABSTRACT

The Connecticut Hill Wildlife Management Area had no snowshoe hare population when it was acquired during the 1930's, following the abandonment of farming operations. Then a reforestation program was undertaken, and between 1931 and 1953 a total of 578 hares from various sources were liberated. During the winters of 1971-72, 1972-73 and 1973-74, snow-track counts and other observations were made at 31 sites selected as representative of the 17.1-square-mile area. Population estimates derived from these data indicated 124, 32 and 40 hares for the three years, respectively. No significant relationship was found between track frequency and habitat acreage, elevation, slope or cover type. With respect to cover composition, however, sites having Norway spruce and/or white pine as the dominant trees species had significantly more tracks than did those without these species. The frequency and abundance of these two conifers was considered to be the most influential factor affecting hare distribution on the area. Furthermore, it was concluded that the availability of suitable winter shelter easily accessible from feeding areas, rather than the food supply itself, is the primary factor limiting hare abundance on this marginal range.

According to early records summarized by Dell (1951), the snowshoe hare (*Lepus americanus*) once ranged throughout New York State, with the possible exception of Long Island. As forests were cleared for cultivation snowshoe habitat diminished and the hare disappeared from most of its former range in the State outside the Adirondack and Catskill regions. With the economic depression of the 1930's eliminating most of

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the marginal farming operations and leading to the abandonment of many others, thousands of farms and unproductive fields were turned back to an unused state. Plant succession toward a forest cover was accompanied by efforts of the State Conservation Department to restock much of the potential hare habitat. To accomplish this, hares purchased from other states, raised on game farms or trapped in the Adirondack region were released in several localities in central and western New York. One such area was a large tract located southwest of Ithaca and now known as the Connecticut Hill Wildlife Management Area.

Although the released hares are known to have survived and reproduced on Connecticut Hill, information concerning their numbers, choice of habitat and distribution is meager. This paper reports the results of a 3-year investigation designed to evaluate the population status and distribution of the hare on this area.

STUDY AREA

The Connecticut Hill Wildlife Management Area (Figure 1) consists of nearly 11,000 acres and is located about 15 miles southwest of Ithaca (N.Y.) in the towns of Newfield in Tompkins County and Catherine in Schuyler County. Connecticut Hill lies in the Glaciated Allegheny Plateau region of the Appalachian Plateau and is a part of the Valley Head Moraines (Fenneman, 1938). Connecticut Hill proper is a long north-south ridge with much of the upland rather level or gently rolling. The highest point is 2,100 feet above sea level and the lowest about 1,300 feet. The soils are of the Volusia-Lordstown association and are very low in lime content with a strong fragipan (Neeley, 1965). Dethier and Pack (1963) reported the seasonal and daily weather to be highly variable from year to year. In most years, annual rainfall totals between 30 and 40 inches. Heavy snowfall begins in early or mid-November, and snow cover extends to mid-April. The annual snowfall averages about 70 inches. All roads on the area are closed to conventional vehicles after the first heavy snow, and winter field work must be carried out with the aid of snowshoes.

A synopsis of the past use of this region was given by Bump (1950) who reported that Connecticut Hill was forested when the first settlers arrived in 1795. By 1840, about two-thirds of the area had been cleared for cultivation or pasture. Farming activity reached its climax around 1880 and declined thereafter. By 1927, only a few families remained on the area. During the period 1925-1930, large-scale farm abandonment occurred, and the woodlots were logged for maximum financial return. By 1938, the State Conservation Department had purchased most of the abandoned land and designated it the Connecticut Hill Game Management Area.

An important part of the State's early management consisted of re-

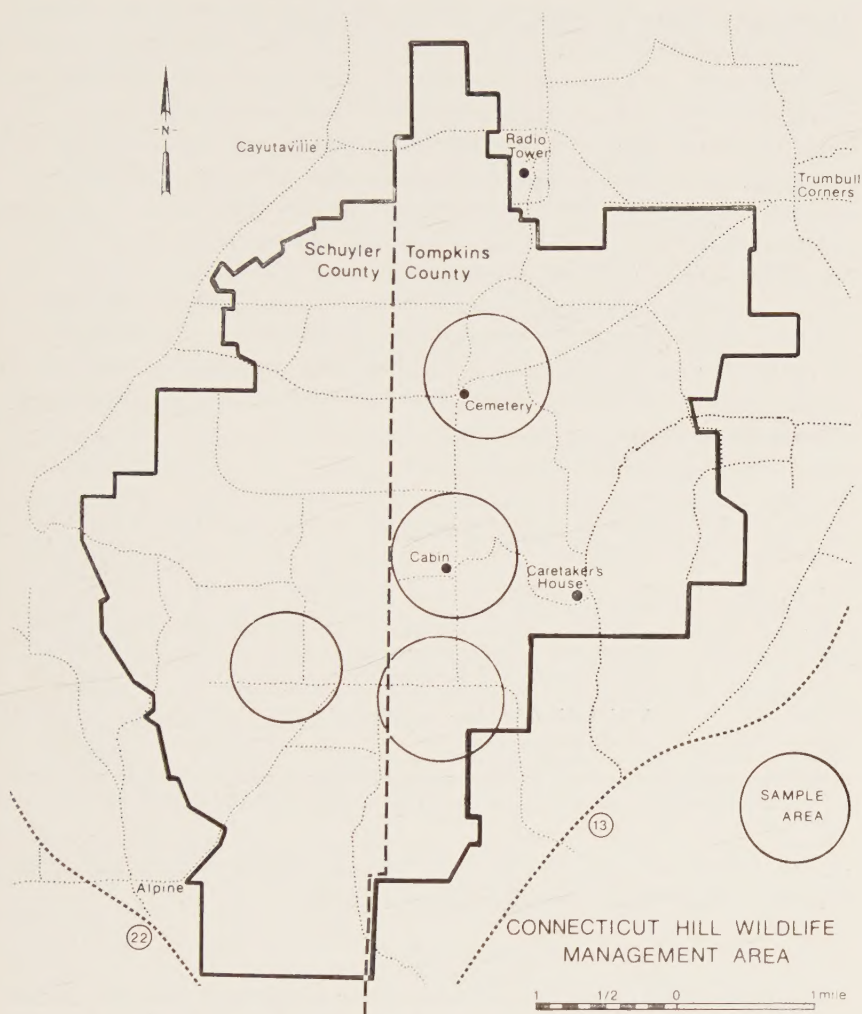


Figure 1. Simplified map of the Connecticut Hill Wildlife Management Area showing landmarks, identifying roadways and the four major areas that included nearly all of the sampling sites and road-crossing points.

forestation (Table 1). According to Bump (1950), in 1928 the 2,089-acre grouse study area on Connecticut Hill consisted of 57 per cent open land, 13 per cent overgrown land and only 30 per cent woodland. Calculations from a 1964 air photo map prepared by the Conservation Department show that at that time open and overgrown lands together occupied only 21 per cent of the total. The many thousands of conifer and hardwood seedlings planted, coupled with unabated plant succession,

TABLE 1. SUMMARY OF TREES AND SHRUBS PLANTED ON CONNECTICUT HILL*

Year	Species	Number of seedlings
1930	Red oak (<i>Quercus rubra</i>)	2,100
	White oak (<i>Quercus alba</i>)	2,100
	Mulberry (<i>Morus</i> sp.)	4,500
	Japanese barberry (<i>Berberis</i> sp.)	1,000
	Gray dogwood (<i>Cornus</i> sp.)	500
	Flowering dogwood (<i>Cornus florida</i>)	500
1936	White pine (<i>Pinus strobus</i>)	20,000
	Red pine (<i>Pinus resinosa</i>)	10,000
	Norway spruce (<i>Picea abies</i>)	5,000
	Flowering dogwood (<i>Cornus florida</i>)	4,690
	Shadbush (<i>Amelanchier intermedia</i>)	1,155
	Gray birch (<i>Betula populifolia</i>)	6,000
	Black locust (<i>Robinia pseudoacacia</i>)	5,000
1939	Mountain laurel (<i>Kalmia latifolia</i>)	200
	White spruce (<i>Picea glauca</i>)	15,000
1941	Red pine (<i>Pinus resinosa</i>)	570,000
	Norway spruce (<i>Picea abies</i>)	1,300
	Hardwoods (spp.)	20,000
	Shrubs (spp.)	56,000
1942	Oak (<i>Quercus</i> sp.)	75,000
	Box elder (<i>Acer negundo</i>)	66,000
	White elm (<i>Ulmus americanus</i>)	1,500
	Black cherry (<i>Prunus serotina</i>)	2,000
	Red maple (<i>Acer rubrum</i>)	3,600
	White ash (<i>Fraxinus americana</i>)	500
	Larch (<i>Larix</i> sp.)	30,500
	Pine (<i>Pinus</i> sp.)	29,000

* Obtained from annual reports of New York State Conservation Department.

caused closure of most of the open fields and pasture land and have turned several areas into stands of maturing forest.

METHODS

Hartman (1960) described a direct linear relationship between tracks per chain and hares per square mile in Algonquin Park in Ontario such that 0.008 track per chain equals one hare per square mile. He compared several censusing techniques, and a subsequent trap-out of his study area indicated that the number of hares can be estimated reliably from track counts if the counts are taken under suitable conditions. The most important condition to be met is that there be a fresh snowfall which ceases before sunset on the day preceding the track count. In this way only the hare activity for one night is recorded. Other conditions that must be considered include rain, high wind and heavy snowfall (4 inches or more) all of which reduced hare activity.

Since weather conditions modify hare activity, the authors felt that only snow-track data collected on the same day in different habitats

should be used for a given sample. Accordingly, 31 different sites were chosen to represent as many habitat types as possible. On days when snowfall had ceased by 5:00 p.m. the previous day, hare tracks were recorded at each of these sites. With the aid of a compass, the observer walked a straight line of 200 paces (6 chains). Additional samples were obtained by turning a right angle and walking 100 paces and again turning a right angle and walking another 200-pace line. Only those tracks encountered on the 200-pace lines were counted. Tracks of the snowshoe hare and the cottontail rabbit (*Sylvilagus floridanus*) were easily separated because of the much larger hind-foot print of the hare.

Hares were also live trapped and marked. Wooden box traps with wire mesh closing one end and a trap door at the other were set 20 to 30 paces apart. Apples of different varieties were used for bait. Captured hares were measured (ear and hind foot), sexed, toe clipped and weighed. Both the toe-clipping technique and numbering system were adopted from Dell (1957). After being toe clipped, individual hares could be easily identified by their tracks on the snow provided that tracking conditions were suitable.

Only a very few days each winter afforded the precise conditions for obtaining reliable activity data. Moreover, the number of tracks encountered during sampling was first a reflection of hare activity and secondly an indication of population density. Nevertheless, population estimates, based on the data recorded, were derived.

When snow conditions were not suitable for counting tracks or individual tracking, cruising was done to record the general activities and range of the hares. After a fresh snow and during optimum tracking conditions, road crossings by hares were also recorded. All hare crossings were plotted on an air photo map and later were examined to reveal use patterns and habitat preference. Figure 1 shows the four major areas that included nearly all of the sampling sites and road-crossing points. Cruising was carried out over the entire management area.

TABLE 2. KNOWN LIBERATIONS OF SNOWSHOE HARES ON CONNECTICUT HILL WILDLIFE MANAGEMENT AREA*

Year	Number	Source
1931	100	Wild trapped in Maine and Wisconsin
1934	111	Same as above
1936	116	Same as above
1941	27	Wild trapped in New Brunswick and Ontario
1945	166	Delmar game farm (N.Y.)§
1952	43	Wild trapped in Adirondack region (N.Y.)
1953	15	Same as above

* Data obtained from annual reports of New York State Conservation Department and personal correspondence with Joseph Dell and Donald Schierbaum.

§ Dell (1951) reported that Connecticut Hill was one of seven areas where hares were not present at the time game farm stock was liberated.

TABLE 3. CHARACTERISTICS OF SNOWSHOE HARE CENSUS SITES ON CONNECTICUT HILL AND SNOW TRACKS RECORDED ON CENSUS DATES IN 1972, 1973 AND 1974

Site*	Acres	Elevation (feet)§	Slope	Cover		Snow tracks per chain††			
				Type†	Composition‡	March 26 1972	March 22 1973	Decem- ber 16 1973	March 23 1974
G 12	32	1800-2000	South	OF	Haw, As, 0-50% open	0.0	0.0	0.0	0.0
G 24	12	1800-2000	South	SS	WP, RM, As	0.0833	0.0	0.0	0.0
H 2	125	1800-2000	North	ST	RM, He, RO, Be, WA	0.0	0.0	0.0	0.0
H 12	27	1800-2000	South	PT	WP, RM, As, WB	0.0	0.0	0.0	0.0
H 13	13	1800-2000	North	OF	0-50% open	0.0	0.0	0.0	0.0
I 1	25	1800-2000	North	PT	WP, As, Wa	0.0833	0.0	0.0	0.0
M 1	14	1800-2000	North	PT	NS, WR, RP	0.0	0.0	0.0	0.0
M 8	56	1800-2000	South	ST	WP, RM, As, RO	0.0	0.0	0.0	0.0
M 18	30	1800-2000	North	PT	RP	0.0	0.0	0.0	0.0
R 9	36	1800-2000	West	PT	WP, RM, RO	0.1667	0.0	0.0	0.0
R 12	22	1800-2000	West	ST	WP, RM, As	0.4167	0.1667	0.1667	0.1667
R 23	12	1800-2000	South	SS	NS, WP, RM, WS	0.2500	0.1667	0.1667	0.0
S 10	18	1600-1800	South	OF	WP, NS, shrubs, 0-50% open	0.0	0.0	0.0	0.0
S 13	20	1600-1800	South	PT	NS, WP	0.0	0.0	0.0	0.0
S 14	139	1800-2000	South	ST	RM, He, RO, Be, WA	0.0	0.0	0.0	0.0
S 15	15	1800-2000	South	PT	WP, RM, As, He	0.2500	0.3333	0.3333	0.3333
T 8	44	1800-2000	East	SS	WP, RM, As	0.0	0.0	0.0	0.0
T 14	13	1600-1800	South	PT	WP	0.0	0.0	0.0	0.0
T 15	14	1800-2000	South	PT	RP	0.0833	0.0	0.0	0.0
U 12	10	1600-1800	North	PT	NS	0.0833	0.0	0.0	0.0
U 22	35	1400-1600	South	OF	NS, shrubs, 0-50% open	0.0833	0.0	0.0	0.0
U 23	21	1400-1600	South	PT	NS, RP, WS	0.0833	0.0	0.0	0.0
V 13	35	1400-1600	South	OF	Shrubs, 0-50% open	0.2917	0.0833	0.1667	0.1667
V 14	9	1400-1600	South	SS	NS	0.0	0.0	0.0	0.0
V 24	47	1400-1600	South	ST	WP, RM, As, He, Be	0.0833	0.0	0.0	0.0
V 25	9	1400-1600	South	SS	NS	0.2500	0.0	0.0	0.0

W 6	13	1400-1600	West	PT	NS, WP	0.0833	0.0	0.0
W 7	34	1400-1600	West	PT	NS, RP	0.0833	0.0	0.0
W 9	27	1600-1800	South	PT	RP	0.0	0.0	0.0
W 11	17	1600-1800	South	OF	0-50% open	0.0	0.0	0.0
W 12	10	1600-1800	South	PT	NS, WP, As	0.0	0.0	0.0

* An area of the same cover type and composition, surrounded by areas of different types and composition. Designations adopted from 1964 air photo map prepared by State Department of Environmental Conservation.

§ Above sea level.

† Represents successional stage of stand according to average diameter at breast height (dbh) of dominant tree species: OF—open field; SS—seedling-sapling (dbh=0"-6"); PT—pole timber (dbh=6"-11"); ST—saw timber (dbh=11"-14").

‡ Dominant trees species: As—aspens; Be—beech; Haw—hawthorn; He—hemlock; NS—Norway spruce; RM—red maple; RO—red oak; RP—red pine; WA—white ash; WB—white birch; WP—white pine; WS—white spruce.

‡‡ From track counts over a minimum of two 6-chain census routes at each site, except that single 6-chain routes were run at Sites H 2, M 8 and S 14. (1 chain=66 feet)

RESULTS AND DISCUSSION

According to Bump (1941), some 25,700 hares were released in New York State between 1926 and 1933, and another 32,700 between 1933 and 1937. The recorded liberations on Connecticut Hill (Table 2) included 354 released between 1931 and 1941 and 224 released between 1941 and 1953. Apparently, the stocking prior to 1941 was in vain because Dell (1951) reported that hares were not present at the time game-farm-reared animals were released in 1945. Since subsequent releases of wild-caught hares were made in the early 1950's, it is not known whether the hares surviving at the time of the survey had derived from farm-reared or wild-caught stock or a combination of both.

POPULATION ESTIMATES

Ideal weather conditions for the first track count came on March 26, 1972. Data collected on that date at the 31 sampling sites are shown in Table 3. They gave an average of 0.0847 track per chain or, after applying Hartman's convention (i.e., 0.008 track per chain=1 hare per square mile), 10.6 hares per square mile. Extrapolation of this value to the entire 17.1-square-mile management area would indicate 181 hares at the time of sampling (Table 4). However, since the study showed that hare distribution among different cover types was not uniform, perhaps a better estimate is obtained by using only the track index from those habitats known to support hares and extrapolating only to those areas. Approximately 55 per cent of the total management area (9.4 square miles) was known to support hares. The track counts for those sites averaged 0.1054 per chain which, using Hartman's conven-

TABLE 4. ESTIMATES OF SNOWSHOE HARE POPULATION ON CONNECTICUT HILL WILDLIFE MANAGEMENT AREA AS DERIVED FROM SNOW-TRACK COUNTS

Year and season	In terms of total area (17.1 square miles)			In terms of hare habitat (9.4 square miles)		
	Average tracks per chain	Hares per square mile*	Total hares	Average tracks per chain	Hares per square mile*	Total hares§
1972						
Spring (Mar. 26)	0.0847	10.6	181	0.1054	13.2	124
Fall (Dec. 8)†	..	..	..	0.0112	1.4	13
1973						
Spring (Mar. 22)	0.0219	2.7	46	0.0272	3.4	32
Fall (Dec. 16)	0.0273	3.4	58	0.0340	4.3	40
1974						
Spring (Mar. 23)	0.0273	3.4	58	0.0340	4.3	40

* Based on ratio of 0.008 track per chain=1 hare per square mile (Hartman, 1960).

§ Considered the better estimate of the total population on the area (see text).

† Data from only 12 of 31 sites.

tion, indicated 13.2 hares per square mile. Applying this value to the area of occupied habitat, a more conservative estimate of 124 hares was obtained. Other observations during live-trapping operations and general cruising of the area in the winter of 1971-72 indicated the latter estimate to be the more reasonable.

In 1973 snowfall was infrequent and light on the study area. However, on March 22, optimum conditions prevailed for the collection of data from the same 31 sites. An average of 0.0219 track per chain indicated a population of 2.7 hares per square mile or 46 for the entire 17.1-square-mile area (Tables 3 and 4). Again considering only the habitat supporting hares, a better estimate of 32 hares was obtained.

These data, as well as other information gathered from cruising and road-crossing track counts, clearly pointed to a severe reduction in the hare population between March 1972 and March 1973. Indirect evidence, including a reduction in the total number of tracks encountered in April of 1972 and the disappearance of all toe-clipped hares, suggests that the decline may have come abruptly in the spring of 1972. Although tracking conditions the following November and December were poor and prevented accurate track counts on all 31 sites, there was no evidence that the population had recovered. Counts on 12 sites on December 8, 1972 indicated very few hares in the habitats sampled (Table 4). In fact, until the complete census of March 22, 1973 was made, it appeared that fewer than 15 hares remained on the management area.

Snow-track counts under optimum conditions were made at all the 31 sampling sites on December 16, 1973. The average number of tracks for the habitats supporting hares was 0.0340 per chain which gave an estimate of 40 hares in the early winter population. A comparable count on March 23, 1974 indicated a corresponding population of 40 hares. The figures for both dates are given in Tables 3 and 4. These data indicated little change in population density for the 3-month period.

The drastic decline in the hare population on Connecticut Hill after the winter of 1971-72 may have been a phase of the approximately 10-year cyclic fluctuation in abundance ascribed to this species. Hunter-take records for New York State as a whole (begun in 1918 and discontinued in 1948) indicated pronounced peaks at roughly this interval from about 1920 to about 1950 (New York State Conservation Department, 1919-1951). Reports for Michigan by Bookout (1963) and Manitoulin Island (Ont.) by Newson and deVos (1964) indicated peaks in hare numbers about 1960 in that region. Although data are lacking, perhaps there was a peak about 1970 on Connecticut Hill. Reasons for the decline are unknown. No instances were observed in either 1972 or 1973 of mortality from hunting or predation. Two juvenile hares were trapped in July of 1973, demonstrating that some reproduction occurred between the census periods.

HABITAT SELECTION AND USE

As a result of the reforestation program on Connecticut Hill in the 1930's and early 1940's, there existed at the time of the survey a mosaic of cover types that included pure and mixed stands of conifers and hardwoods of various acreages. The 31 sampling sites were chosen to represent as many habitat combinations as feasible. The cover type and its composition at each site, together with the acreage, elevation and slope, are included in Table 3 which gives the frequency of hare tracks recorded on each census. In Table 5, the data for these categories are summarized. Within the several categories, the significance of variations in use was tested by calculating the *F*-values and student's *t* (Steele and Torrie, 1960).

No significant difference was found among the different classes within the categories of acreage, elevation, slope and cover type. Moreover, a multiple regression analysis revealed no significant correlations and hence no meaningful relationships between these habitat parameters and the number of hare tracks. With respect to cover composition, however, those classes having Norway spruce and/or white pine as the dominant trees species had significantly ($P \leq .05$) more tracks than did those without these species. Also, very few road crossings by hares were recorded between cover types lacking Norway spruce and/or white pine, whereas in situations where these species occurred on both sides of the road such crossings were numerous. On the basis of these data and other observations during the study, the relative frequency and abundance of these two conifers was the most influential factor affecting hare distribution on the area.

Open fields were rarely used by hares, but the seedling-sapling stages of succession were an important part of their habitat. Edges and small openings were used as foraging areas where an understory of coniferous shelter was nearby. In some situations, brush piles were heavily used and may have been crucial in the survival of hares where conifers were sparse or absent.

During the present study, use of runways was not heavy. Runways with one or two sets of tracks were the most common, although runways with three or four sets were seen occasionally in the spring of 1972. On several occasions hare tracks were followed for 100 meters or more, often in a straight line which seemed to indicate that the hare was heading toward a predestined place. In many instances these tracks led to an area of heavy feeding activity. At nearly all of these feeding sites a clump of 10 or more spruce trees was found that did not appear on the cover map. In no instance, however, were spruce clippings found at these sites nor was evidence of hare damage to the trees noted. Apparently, the spruce were being used primarily for shelter.

TABLE 5. RELATIONSHIP OF VARIOUS HABITAT CHARACTERISTICS ON CONNECTICUT HILL WILDLIFE AREA TO FREQUENCY OF SNOWSHOE HARE TRACKS

Class	Sites sampled		Tracks per chain			
	Number	Total chains	March 26 1972	March 22 1973	December 16 1973	March 23 1974
Acreage						
0- 9	2	24	0.1250	0.0	0.0	0.0
10- 19	12	144	0.0694	0.0278	0.0278	0.0278
20- 29	6	84	0.1548	0.0476	0.0714	0.0714
30- 39	6	72	0.0556	0.0	0.0	0.0
40- 49	2	24	0.0417	0.0	0.0	0.0
50- 59	1	6	0.0	0.0	0.0	0.0
120-129	1	6	0.0	0.0	0.0	0.0
130-139	1	6	0.0	0.0	0.0	0.0
Total	31	366	0.0847	0.0219	0.0273	0.0273
Elevation						
1800-2000	16	174	0.0920	0.0345	0.0345	0.0345
1600-1800	7	84	0.0119	0.0	0.0	0.0
1400-1600	8	108	0.1296	0.0185	0.0370	0.0370
Total	31	366	0.0847	0.0219	0.0273	0.0273
Slope						
North	6	66	0.0303	0.0	0.0	0.0
South	20	240	0.0833	0.0250	0.0333	0.0333
East and west	5	60	0.1500	0.0333	0.0333	0.0333
Total	31	366	0.0847	0.0219	0.0273	0.0273
Cover type						
Old field	6	72	0.0139	0.0	0.0	0.0
Seedling-sapling	5	60	0.1167	0.0333	0.0333	0.0
Pole timber	15	192	0.0885	0.0208	0.0313	0.0417
Saw timber	5	42	0.1429	0.0476	0.0476	0.0476
Total	31	366	0.0847	0.0219	0.0273	0.0273
Cover composition*						
Norway spruce	6	84	0.1548	0.0233	0.0476	0.0471
White pine	10	114	0.1140	0.0351	0.0351	0.0526
Norway spruce and white pine	6	72	0.0556	0.0278	0.0278	0.0
Other	9	96	0.0104	0.0	0.0	0.0
Total	31	366	0.0847	0.0219	0.0273	0.0273

* Species listed denotes sites where that species was one of the dominant trees; "other" denotes sites where neither Norway spruce nor was white pine dominant although both were occasionally found.

Hares were observed to feed most frequently near white pine or Norway spruce having widespread limbs near the ground. Heavily used feeding sites were easily recognized by the numerous tracks, hard-packed

snow on the ground, clippings and usually fecal pellets. Red pine plantations, where most of the lower limbs were either dead or missing and the thick canopy had effectively obliterated ground vegetation, were little used. Brooks (1955) reported that in West Virginia the heaviest hare populations were found in young stands of spruce in the sapling and pole stage. This pattern of distribution was also observed during all three winters of the present study.

CONCLUSIONS

The Connecticut Hill Wildlife Management Area probably constitutes only marginal range for the snowshoe hare. Observations during the present study suggest that the availability of suitable winter shelter easily accessible from feeding areas, rather than the food supply itself, is the primary limiting factor. Cover types in which Norway spruce and/or white pine were dominant were most favored for winter shelter, although hardwood stands interspersed with these conifers were also used. Edges and small openings were used as foraging areas where such shelter was nearby. Where shelter is inadequate, creation of brushpiles might be beneficial. Although it is believed that hare abundance may have been at a peak, for this range, about 1970, the population density declined sharply during this study and reached a very low level in 1973.

LITERATURE CITED

- BOOKOUT, T. A. 1963. The snowshoe hare in upper Michigan: its biology and feeding coactions with white-tailed deer. Ph.D. thesis, Univ. Mich. Library.
- BROOKS, M. 1955. An isolated population of the Virginia varying hare. *Jour. Wildl. Mgt.* 19(1):54-61.
- BUMP, G. 1941. The introduction and transplantation of game birds and animals into the State of New York. *Trans. N. Am. Wildl. Conf.* 5:409-420.
- 1950. Wildlife habitat changes in the Connecticut Hill Game Management Area. *Cornell Univ. Agri. Exp. Sta. Memoir* 289.
- DELL, J. 1951. Possibilities for re-establishing the varying hare in certain parts of New York State. New York Federal Aid in Fish and Wildlife Restoration Project W-22-R (separate report for Job II-C). N.Y.S. Cons. Dept. (mimeo.)
- 1957. Toe clipping varying hares for track identification. *N.Y. Fish and Game Jour.* 4(1):61-68.
- DETHIER, B. E., and A. B. PACK. 1963. The climate of Ithaca, N.Y., climatological summary. Urban Climate Series No. 1, N.Y.S. Coll. Agri.
- FENNEMAN, N. M. 1938. *Physiography of Eastern United States*. McGraw-Hill Book Co., New York.
- HARTMAN, F. H. 1960. Census techniques for snowshoe hares. M.S. thesis, Mich. State Univ. Library.
- NEELEY, J. A. 1965. Soil survey of Tompkins County, New York. U.S. Dept. Agri., Series 1961, No. 25.
- NEWSOM, R., and A. DeVOS. 1964. Population structure and body weights of snowshoe hares on Manitoulin Island, Ontario. *Can. Jour. Zool.* 42(6): 975-986.
- NEW YORK STATE CONSERVATION DEPARTMENT. 1919-1951. Annual reports for 1918 to 1950.
- STEELE, R. G. D., and J. H. TORRIE. 1960. *Principles and Procedures of Statistics*. McGraw-Hill Book Co., New York.

OBSERVATIONS ON THE RAINBOW SMELT IN LAKE GEORGE, NEW YORK¹

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ABSTRACT

Observations on spawning runs of rainbow smelt (*Osmerus mordax*) in Smith Bay Brook and Hague Brook, tributaries of Lake George, during April 1974 are presented. These are thought to have been the first for this lake. The spawning fish belonged predominantly to the 0+ age group. Implications of the presence of smelt in the ecosystem are discussed.

This report constitutes the first recorded account of spawning runs of the rainbow smelt (*Osmerus mordax*) in Lake George, New York. Prior to the runs, single male specimens were taken, on March 22, 1974 and April 1 and 18, 1974, in 1/2-inch-bar gill netting set at a depth of about 7 meters on the eastern shore of the north basin at Smith Bay. To the best of our knowledge, these were the first specimens of the species ever taken from Lake George. Because of the recognized (Van Oosten, 1937, 1947a, 1947b) ability of the species to expand rapidly and to influence other species when it newly enters a lake, these events are herewith being put on record for future reference.

OBSERVATIONS ON SPAWNING RUNS

The first observations of the spawning run began at 9:00 on the night of April 23-24, 1974 in Smith Bay Brook, the locale of the earlier gill netting. The stream has lower-course widths of 1 to 3 meters, average depths of about 25 centimeters and a bed of boulders, gravel, sand and silt. An underwater sealbeam light was used and appeared to have little influence on the activity of the fish. The sky was overcast, a fine rain was falling and the lake surface was generally calm. Water temperature was 7.5° C. in the brook and 7° C. at the surface of the lake.

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Most fish swam within 10 centimeters of the bottom, shifting from place to place while heading into the current. Typically, a total of 20 to 40 fish of two size groups were evident over about 15 square meters of bottom. Grouping was loose and irregular but with a clear upstream orientation maintained by periodic bursts of caudal sweeping. From time to time, smaller fish approached the flanks of a large individual from the rear, vibrating and touching the larger fish for several seconds. Close observation revealed small ejections of material by the larger fish during these encounters.

It was possible to reach into the water and grasp specimens and to discharge eggs from the larger individuals and milt from the smaller ones. When eggs were expressed under water they attached within a second or less to our hands. Collection of egg-bearing stones and observation under a dissecting microscope revealed the presence of thread-like attachment pedicels which had also entangled a number of sand grains. Study of eggs still present in the ovaries showed no such elaborations, corroborating observations by others that thread formation results from modification of an adhesive coating. When the milt was released it vanished into the water instantly, as if under the influence of a dispersant, which explains why the milt was not seen during the spawning. The observed ratio of males to females was roughly four to one.

Observations on the night of April 25, 1974 revealed some 35 individuals spawning. Spawning activity continued on April 27 when 15 smelt were observed, two of which were large and thus probably females. About 30 smelt were again observed on April 29, the ratio of males to females being less than previously noted and about three to one.

In the course of various observations, other species were noted, i.e., several rainbow trout (*Salmo gairdneri*), numerous johnny darters (*Etheostoma nigrum*), several slimy sculpins (*Cottus cognatus*), several banded killfish (*Fundulus diaphanus*), a few yellow perch (*Perca flavescens*), a single cisco (*Coregonus artedii*) and several unidentified minnows.

Gull Bay Brook, about 2 kilometers north of Smith Bay, was also examined on April 25, but no smelt were seen. However, Warren Batchelder, an experienced fisherman, observed a single smelt in this brook on the evening of April 27, 1974.

Ernest Lantiegne and Bruce Shupp, fisheries biologists of the State Department of Environmental Conservation, collected, by means of an electroshocker, 82 specimens from the mouth of Hague Brook in mid-afternoon of April 25, 1974. During the same afternoon they examined other streams of the west shore (i.e., Cape Cod Brook, Northwest Bay Brook, Indian Brook and Alexander Brook) but found only four indi-

viduals in Alexander Brook, a small stream in the Hague area. Subsequently, the authors took four smelt while netting suckers in Hague Brook on the night of May 2, 1974.

The stomachs of specimens collected on April 23-24 were empty, the results being similar to other observations (e.g., Van Oosten, 1947b; Scott and Crossman, 1973). In general, the observations on spawning closely followed those of Langlois (1935) and Hoover (1936).

EXAMINATION OF SAMPLES

Collection by shore seine in the waters at the mouth of Smith Bay Brook produced 87 specimens, 13 of which were preserved without examination for later detailed taxonomic study. Of the 74 examined, 61 (82.4 per cent) were males. Females were larger, averaging 136.8 millimeters in total length and 16.9 grams in weight, while the males averaged 117.9 millimeters and 9.1 grams, respectively (Table 1). Age-group composition showed a preponderance of youthful spawners; of the 74 fish, 60 were age 0+, 12 were age 1+ and only one female was age 2+.

Comparison with the sample taken from Hague Brook (Table 2) further attests to the youthful nature of the spawning group. Although the

TABLE 1. MORPHOMETRY AND AGE COMPOSITION OF RAINBOW SMELT TAKEN AT MOUTH OF SMITH BAY BROOK ON APRIL 23-24, 1974

Sex	Number	Mean total length (millimeters)	Mean weight (grams)	Age (years)*		
				0+	1+	2+
Male	61	117.9	9.1	51	8	..
Female§	13	136.8	16.9	9	4	1
Total	74	121.2†	10.5†	60	12	1

* Total is one less than 74 because one scale set was lost.

§ Average ovary weight (2.95 grams) represented 15.8 per cent of total body weight.

† Weighted average.

TABLE 2. TOTAL LENGTH ACCORDING TO AGE FOR RAINBOW SMELT TAKEN AT MOUTH OF HAGUE BROOK ON APRIL 25, 1974*

Age 0+		Age 1+		Total	
Number	Mean total length (millimeters)	Number	Mean total length (millimeters)	Number	Mean total length (millimeters)
23	147.8	8	187.6	31	160.2
..	..	..	..	82§	146.9

* Sex was not determined.

§ Represents the total sample and includes the 31 shown above for which scale sets were collected.

mean size of the 82 fish measured was significantly greater than that of those from Smith Bay Brook, the divergent weights and times of appearance of the two sexes could easily explain this.

APPEARANCE OF FRY

On June 4, a submersible light was suspended from the dock of the Fresh Water Institute at Smith Bay and fry were collected. Identification was based on Fish (1932). Fry were again collected by night lighting off Burnt Point to the south of Smith Bay on June 19. Midwater trawling at various depths in and above the thermocline in mid-lake between the village of Hague on the west shore and the Fresh Water Institute on the east shore yielded fry on the night of July 5. The only other small fish taken were yellow perch.

ESTABLISHMENT OF THE POPULATION

The events surrounding the establishment of this population remain obscure. The first reported stockings of smelt in Lake George were in 1918 (2,854,000) and 1929 (5,000,000) and consisted of fry taken from a small stream emptying into Cold Spring Harbor on Long Island (Moore, 1930). To the best of our knowledge, these two stocking efforts failed to establish the species in the lake.

A third introduction may have been made in 1941. Evidence for this exists in the form of a letter, dated November 19, 1941, from C. H. Wilson, chairman of the Executive Committee of the Warren County Fish and Game Association, to Harry H. Reoux, the local asssemblyman, in which was discussed the proposed planting of several million smelt eggs in streams near Bolton Landing and about 11 million more in the vicinity of Lake George Village, extending up to and including Indian Brook (file document of State Department of Environmental Conservation). The existence of smaller and larger varieties of smelt is mentioned and, following the advice of Emmeline Moore, the Department's chief aquatic biologist, it was agreed that the smaller was to be stocked in Lake George. The success of this introduction, if indeed it actually took place, also seems unlikely because no collections or verified observations of smelt were made until those reported here.

It thus seems probable that the extant population is the result of quite recent, unauthorized stocking. The run in Smith Bay Brook seemed to be either one or two years old at the most. The stream had been thoroughly checked at night in previous years, exclusive of 1973, for rainbow trout, and it seems highly probable that smelt would have been seen if they were present. Similarly, personnel of the State Department of Environmental Conservation had routinely collected in the mouth of Hague Brook during the latter part of April for many years and had not

taken smelt until 1974. It is possible that, as is the case in nearby Lake Champlain⁴, spawning had taken place in the lake proper and not in the streams and that the population was only beginning to develop the stream-spawning habit. In this case, smelt may have been in the lake for quite some time, but the absence of specimens in the stomachs of lake trout, salmon, pike and bass, the absence of the species in the catch of the ice fishery and the lack of the occasional floating dead specimen strongly suggest that the smelt is a newcomer to the lake.

ECOSYSTEMETIC IMPLICATIONS

The implications of the emergent smelt population as related to other species are complex and of potentially great import. Stomach analyses of smelt from Lake Champlain (Greene, 1930) revealed a diet consisting of smelt, other fish, insect larvae, plankton, opossum shrimp (*Mysis relicta*) and other material. Trout were never observed. Other earlier authors (Creaser, 1925, 1927; Van Oosten, 1947a, 1947b; Lackey, 1969; Schneberger 1937) corroborate the observation that trout fry are not a primary food of smelt. In the Great Lakes, the opossum shrimp is a prominent food (Schneberger, 1937). Amphipods, ostracods, aquatic insect larvae and aquatic worms are also taken, reflecting the use of benthic invertebrates. Fish, including sculpins of the genus *Cottus*, small smelt, small burbot, white bass, whitefish and emerald shiners, also enter the diet and constituted 6 to 10 per cent of the food volume in the material examined by Scott and Crossman (1973). But, regardless of the absence of firm evidence of trout predation by smelt, one must be cautious in assuming that the smelt has no role in the mortality of young lake trout because ice and poor weather conditions make sampling awkward during the late winter when lake trout fry leave the spawning areas.

Efforts to procure specimens of smelt from the main body of Lake George for stomach examination were largely unsuccessful. Three specimens taken by gill netting from a depth of about 20 meters at Cotton Point on July 9, 1974 were examined. One was empty. The other two each contained several opossum shrimp. The stomachs of the three smelt taken from the lake in March and April of 1974 also contained opossum shrimp. A competitive relationship with the cisco, smaller lake trout and yellow perch is thus suggested.

In spite of the fact that all evidence points to little significant predation on lake trout fry by smelt, it has been frequently observed by fishery biologists (e.g., Kendall, 1927) that the emergence of a smelt population often results in the serious decline of other species, including the

⁴It may be noted that, although the outlet of Lake George flows into Lake Champlain, it has an impassable falls barrier.

highly esteemed lake trout. A notable study of the phenomenon related the decline of the cisco (lake herring) to the dramatic increase (or decline) of the smelt in western Lake Superior (Anderson and Smith, 1971). The cisco had shown great stability as the primary commercial species in Lake Superior from 1908 until the mid-1950's when the populations in the vicinity of Duluth collapsed. Catch per unit of effort fell from 556 pounds per 1,000 linear feet in 1953 to 14 pounds in 1966. Prior to 1952 the commercial landings of smelt in western Lake Superior were insignificant, but thereafter catches grew to a level of 1,045,000 pounds in 1964 for the extreme western end of the lake (District M-1) and 619,000 pounds in 1963 for the Wisconsin fishery. The correlation of cisco and smelt abundance in 1951 and 1966, adjusted two years earlier for the Duluth area (District M-1), was highly significant, i.e., $r = -0.674$ ($P=0.01$).

Another form of evidence exists in the recovery of other fish stocks following the decline of smelt populations. The smelt population declined dramatically in Green Bay on Lake Michigan in 1942-43 (Van Oosten, 1947a, 1947b), and during the following spring phenomenal year classes of cisco, lake whitefish and walleye were produced (Hile et al., 1953). Competition and fry predation by smelt when they are at a high level of abundance emerge as possible reasons for the decline of associated fish species.

Application of such studies to Lake George is tenuous at best. The greater average total length of ciscos being taken at the time of this study compared with that of those routinely taken 20 years earlier, along with the nearly total absence of ciscos less than 8 to 9 inches long in the stomachs of lake trout, provide good evidence that cisco reproduction in Lake George was failing at that time. But this seems to be a long-term phenomenon, while the population structure (as indicated by the data in Tables 1 and 2) of the newly found smelt and the absence of earlier observations on its presence suggest the smelt to be a new influence.

That smelt may serve as forage for lake trout is well recognized with respect to Lake Champlain and Cayuga Lake. Furthermore, there is some evidence, from Cayuga Lake at least, that cisco and smelt can coexist for prolonged periods of time (A. Eipper, personal communication).

LITERATURE CITED

- ANDERSON, EMORY D., and LLOYD L. SMITH, JR. 1971. Factors affecting abundance of lake herring (*Coregonus artedii* Lesueur) in western Lake Superior. Trans. Am. Fish. Soc. 100(4):691-707.
- CREASER, C. W. 1925. The establishment of the Atlantic smelt in the upper waters of the Great Lakes. Papers Mich. Acad. Arts and Letters 5:405-424.
- . 1927. The food of the yearling smelt from Michigan. Papers Mich. Acad. Arts and Letters 10:427-431.

- FISH, MARIE P. 1932. Contribution to the early life histories of sixty-two species of fishes from Lake Erie and its tributary waters. Bull. U.S. Bur. Fish. 47(10):293-398.
- GREENE, WILLARD C. 1930. The smelts of Lake Champlain. In: A Biological Survey of the Champlain Watershed. N.Y.S. Cons. Dept.:105-129.
- HILE, RALPH, GEORGE F. LUNGER and HOWARD J. BUETTNER. 1953. Fluctuations in the fisheries of State of Michigan waters of Green Bay. U.S. Fish and Wildl. Serv., Fish. Bull. 54:1-34.
- HOOVER, EARL E. 1936. The spawning activities of fresh-water smelt, with special reference to the sex ratio. Copeia 1936(2):85-91.
- KENDALL, W. C. 1927. The smelts. Bull. U.S. Bur. Fish. 42:217-375.
- LACKEY, ROBERT L. 1969. Food interrelationships of salmon, trout, alewives and smelt in a Maine lake. Trans. Am. Fish. Soc. 98(4):641-646.
- LANGLOIS, T. H. 1935. Notes on the spawning habits of the Atlantic smelt. Copeia 1935(3):141-142.
- MOORE, EMMELINE. 1930. Introduction. In: A Biological Survey of the Champlain Watershed. N.Y.S. Cons. Dept.:9-22.
- SCHNEBERGER, E. 1937. The biological and economic importance of the smelt in Green Bay. Trans. Am. Fish. Soc. 66:139-142.
- SCOTT, W. B., and E. J. CROSSMAN. 1973. Freshwater fishes of Canada. Fish. Res. Bd. Canada, Bull. 184.
- VAN OOSTEN, J. 1937. The dispersal of smelt, *Osmerus mordax* (Mitchill), in the Great Lakes region. Trans. Am. Fish. Soc. 66:160-161.
- . 1947a. Mortality of smelt, *Osmerus mordax* (Mitchill), in Lakes Huron and Michigan during the fall and winter of 1942-43. Trans. Am. Fish. Soc. 74:310-337.
- . 1947b. The smelt, *Osmerus mordax* (Mitchill). Great Lakes Fish. Invest., U.S. Bur. Fish., Ann Arbor, Mich. (mimeo.)

ANNUAL RANGE OF WILD TURKEYS IN SOUTHWESTERN NEW YORK¹

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ABSTRACT

Distances travelled were recorded for some 433 wild turkeys that were trapped and banded in southern Cattaraugus County. Most recovery data represented birds subsequently retrapped or taken by hunters, but some were obtained by radio tracking hens that had been fitted with transmitters. Juvenile hens travelled farthest averaging 16.1 kilometers in the spring, followed by juvenile males which averaged upwards of 9.5 kilometers. Adults of both sexes were much more sedentary. This appears to be the mechanism of the natural spread of turkey populations into unoccupied range.

Knowledge of the annual range of wild turkeys is needed as a basis for effective management. Previous work concerning turkey mobility has been done on Merriam's wild turkey (*Meleagris gallopavo merriami*) in New Mexico by Ligon (1946), on the Rio Grande wild turkey (*M. g. intermedia*) in Texas by Watts (1969), on the Florida wild turkey (*M. g. osceola*) by Powell (1965) and on the eastern wild turkey (*M. g. silvestris*) in Missouri by Ellis and Lewis (1967) and in West Virginia by Bailey and Rinell (1965). The present paper reports on a study of the eastern wild turkey in southwestern New York. It adds to the information reported from the other studies cited and includes data on special factors affecting northern populations. The study was carried on from 1958 to 1974.

The study area proper, i.e., where trapping was done, totalled some 800 square kilometers in southern Cattaraugus County and comprised Allegany State Park and four contiguous towns to the northeast (Figure 1).

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Figure 1. Map of part of southwestern New York showing turkey study area (stippled) composed of Allegany State Park and the towns of Ellicottville, Franklinville, Humphrey and Great Valley in Cattaraugus County. Also shown is the southern border of the Wisconsin ice sheet.

However, the turkeys ranged beyond these limits, so that in a more real sense the study area extended from this central tract to wherever the turkeys wandered by their own volition and their presence was verified.

Geologically, the area is a highly dissected part of the Allegheny Plateau, extending from the lowest valley elevation of 415 meters above sea level to 754 meters. The top of the plateau averages about 677 meters in the southern part of the study area and a little lower to the north. About half the area (all of Allegany State Park and the southern part of the Town of Great Valley) is unglaciated. The remainder was overrun by the Wisconsin ice sheet which enriched the soils, particularly in the valleys and on the terminal moraines, with lime and other rock material from the vicinity of Niagara Falls and Buffalo. The residual rock structure, mainly shale and sandstone, dips about 20 meters per kilometer toward the south, helping to supply many well distributed spring seeps (Glenn, 1903; McClintock and Apfel, 1944).

Allegany State Park is approximately 95 per cent covered by forest, of which about 50 per cent is oak-hickory (primarily adjacent to the Allegheny River and on south- and west-facing slopes) and beech-maple-hemlock (primarily on the north- and east-facing slopes). The general character of the forests in this region has been described by Hough and Forbes (1943) and Gordon (1940). The part of the study area comprising the four towns northeast of the Park has been modified to a greater degree by man. This area of some 477 square kilometers, where most of the data were obtained, is approximately 50 per cent covered by forest (Stout, 1958). In its southwestern corner there is more red oak (*Quercus borealis*) than in the rest of this section which is forested with beech, maple and hemlock. Much of the study area, including Allegany State Park, was farmed by dairymen until the 1930's. However, in many situations on steep slopes or where rocks predominate disturbance has been negligible.

METHODS

A trap and transfer program was carried on in Allegany State Park from 1958 to 1974 (DeGraff, 1973). This was the source of most of the wild turkeys inhabiting New York State that did not move across the border from Pennsylvania. The birds were cannon netted, and about half were transferred (elsewhere in this State as well as to Connecticut, Massachusetts, New Hampshire and Vermont) while the others were banded and released at the trap site. Only data for birds released at the trap site were used for this analysis. Most of the trapping was done in January, February and March, but in 1965 some was done in August and September. Recovery records came from birds that were retrapped or that were shot by hunters.

Preseason banding studies were conducted from 1969 to 1974 (Eaton,

1970-1974; Penrod, 1975). Birds were cannon netted in the four-town part of the study area between August 3, the earliest date, and October 1, the opening of the small game season in the State. They were released at the trap site after being banded with patagial tags and safflag color markers. The primary objective was to determine the percentage of the population subsequently harvested by hunters in the spring and fall, but information was also desired on the movements of retrapped birds, particularly distances travelled to their brood ranges by the hens.

In connection with productivity studies from 1972 to 1974 (Glidden, 1973-1975), certain of the netted hens were banded on both wings with patagial tags and streamers and were also fitted with radio transmitters. These birds were followed through the spring and summer and, in a few cases, into the fall, so that information was obtained on their movements from winter range to nest site and from nest site to brood range and, in a few cases, back to winter range. Males, as well as other females trapped, were banded.

Recovery records were obtained largely from hunters and were supplemented by data for retrapped birds and for hens that were equipped with radio transmitters. During the study, turkey hunting was permitted each fall, beginning in 1959, in Cattaraugus County and adjoining Allegany County. Chautauqua County and southern Erie County, also adjoining, were added in 1961 and 1967, respectively. Beginning in 1968, a spring season during May (for bearded turkeys only) was held in Allegany, Cattaraugus and Chautauqua Counties, with southern Erie County being added in 1971. During each season, the limit was one bird per hunter. Prior to 1968, hunting was done under the regular small game license, and recovery records depended on the voluntary return of bands plus incidental direct knowledge of project personnel regarding birds taken. From 1968 on, for either the spring or fall season, a hunter was required to have a special permit with which was furnished a return envelope in which he was also required to send in one leg and the band, if any, of his turkey if he took one.

Four age categories were recognized: poult, juvenile, yearling and adult. A bird was considered a poult from hatching (about June 1) until December 1, after which it was termed a juvenile until the following June 1. From then to October 1 (when juvenile primaries 9 and 10 had usually been molted) it was considered a yearling, and after that (when 16 months old or older) it was considered an adult.

RESULTS

Distances travelled were recorded for some 433 wild turkeys that were trapped and banded. The records for those taken by hunting were reported on by DeGraff (1974) and are summarized in Table 1. The

TABLE 1. DISTANCE TRAVELLED FROM PLACE OF BANDING TO PLACE OF RECOVERY FOR WILD TURKEYS TAKEN BY HUNTING

Age at tagging	Age at recovery	Male				Female			
		Number	Distance travelled (kilometers)			Number	Distance travelled (kilometers)		
			Average	Minimum	Maximum		Average	Minimum	Maximum
Poult	Poult	78	3.5	0.5	19.2	79	4.5	0.4	28.8
	Juvenile	3	5.1	1.6	8.8	..	..	..	..
	Yearling	14	9.5	1.6	15.2	20	13.1	0.8	40.8
	Adult	9	7.3	1.3	21.6	11	15.3	8.4	48.0
Juvenile	Juvenile	1	1.9	..	..	..	..	..	..
	Yearling	3	2.7	1.6	4.0	..	..	..	..
	Adult	1	3.0	..	..	..	..	..	..
Yearling	Yearling	3	2.7	1.6	4.0	15	3.0	0.8	10.4
	Adult	1	2.9	..	..	8	2.5	1.0	5.6
Adult	Adult	11	2.8	1.6	4.0	13	3.7	0.4	10.1
Total		124	xxx	xxx	xxx	146	xxx	xxx	xxx

TABLE 2. DISTANCE TRAVELLED FROM PLACE OF BANDING TO PLACE OF RECOVERY FOR WILD TURKEYS RETRAPPED

Age at tagging	Age at recovery	Male				Female			
		Number	Distance travelled (kilometers)			Number	Distance travelled (kilometers)		
			Average	Minimum	Maximum		Average	Minimum	Maximum
Poult	Juvenile	6	7.4	6.0	12.0	11	5.3	0.8	14.0
	Yearling	4	6.2	2.4	8.0	13	8.6	3.2	14.4
	Adult	4	5.1	3.2	17.6	5	3.6	6.4	8.4
Juvenile	Yearling	..	..	..	..	1	14.9	..	..
	Adult	1	1.0	..	..	6	5.7	0.0	17.6
Yearling	Adult	..	..	..	..	17	2.3	0.0	8.6
Adult	Adult	3	2.0	0.8	2.9	30	3.0	0.2	10.0
Total		18	xxx	xxx	xxx	83	xxx	xxx	xxx

records for those that were retrapped are summarized in Table 2. Hunting recoveries provided the most data and indicated that the average distance travelled was greatest for birds that had been banded as poults and that survived to become yearlings or adults. These data also indicated that females travelled farther than males.

Hens that were fitted with radio transmitters in February and March yielded the best information on movement from winter range to nest site. Seventeen juvenile hens moved an average distance of 16.1 kilometers. and 30 hens, 1 year old or older, moved an average of 5.5 kilometers

TABLE 3. DISTANCE TRAVELLED FROM PLACE TRAPPED (IN WINTER) TO NEST SITE AND FROM NEST SITE TO BROOD RANGE FOR FEMALE WILD TURKEYS EQUIPPED WITH RADIO TRANSMITTERS

Year	Juvenile		Adult	
	Number	Average distance (kilometers)	Number	Average distance (kilometers)
Place trapped to nest site				
1972	3	14.6	1	1.7
1973	5	15.1	10	2.9
1974	9	17.2	19	7.1
Total	17	16.1	30	5.5
Nest site to brood range				
1973	1	1.1	2	1.8
1974	4	4.5	8	1.9
Total	5	2.7	10	1.9

(Table 3). The movements recorded for 10 of a flock of 13 hens in the winter and spring of 1973 are shown in Figure 2. The spring breakup of large flocks of hens on winter range into nesting groups (Watts, 1969) and then to individual nesting birds is associated with the greatest annual movement.

Hens are least mobile during egg laying and incubation, after which there is a lesser movement to brood range which may include pasture land or small forest openings and their edges. This movement to brood range, again recorded by radio tracking, averaged 2.7 kilometers for five juvenile and yearling hens with poults, and 1.9 kilometers for 10 adult hens with poults (Table 3).

Hens and their poults remained together on the brood range through June, July and August, and often until mid-September, when there was a fairly distinct movement into areas of mature woods where feeding centered on one or more of four mast crops when available. In order of preference, these were beech (*Fagus grandifolia*), black cherry (*Prunus serotina*) red oak and white ash (*Fraxinus americana*) as discussed by Eaton et al. (1970). This movement is best illustrated by data for poults banded on the brood range and then shot 2 or 3 months later in late October or early November. The records for 1969 through 1973 are given in Table 4. In these years, 149 poults moved an average of 3.5 kilometers from summer to fall and winter range. Males averaged 3.3 kilometers and females 3.7 kilometers. For 23 birds banded on their summer range as yearlings and taken on their fall and winter range as yearlings or adults, the average distance travelled was 3.1 kilometers.

Also, 23 poults, not killed the first fall but taken the second fall after

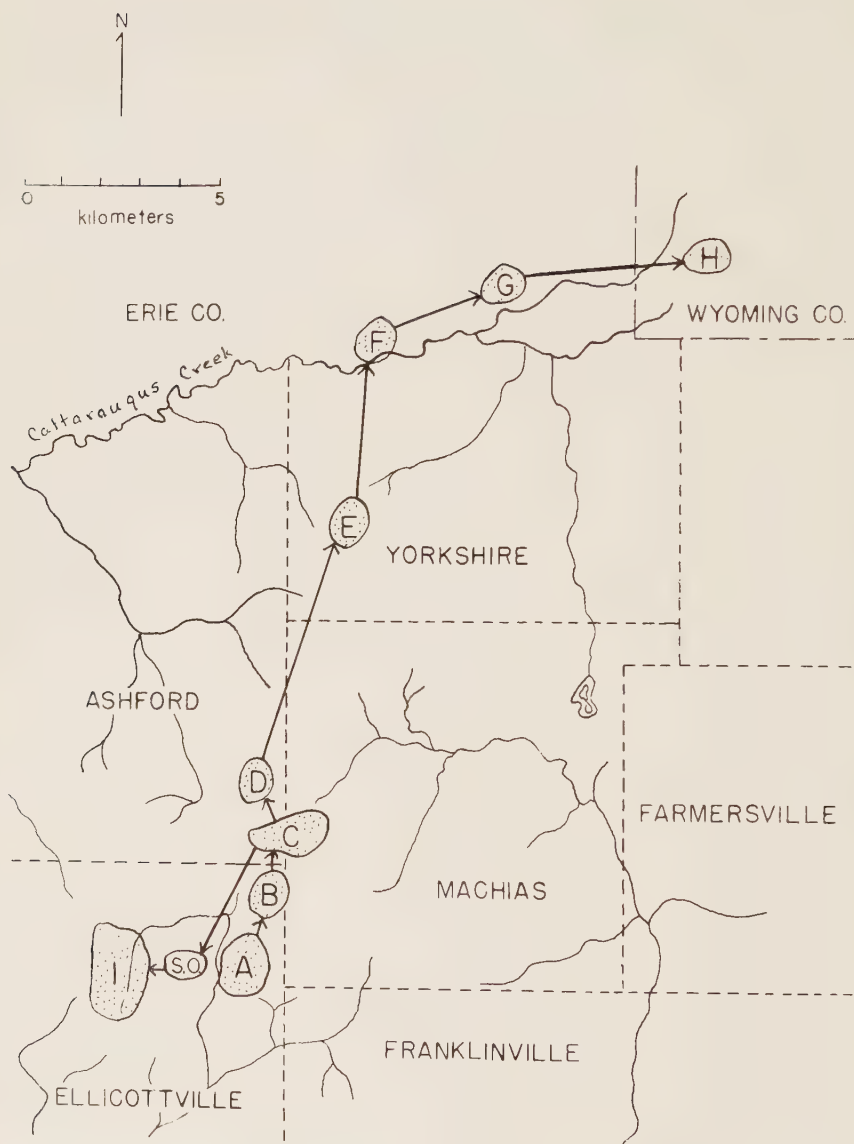


Figure 2. Movements of 10 of a flock of 13 hen turkeys from their winter range through the spring break-up. These 10 birds were successfully equipped with radio transmitters on February 19, 1973 at "A" and stayed together until the break-up at "C" on March 29. Four adults and one yearling stayed near "C" and "D", while two yearlings travelled northward to "E", "F" and "G" and were lost at "H" on April 7. Three adults left the break-up at "C" and travelled to "I" where they nested. (S.O.=sight observation)

TABLE 4. DISTANCE TRAVELLED BY BANDED WILD TURKEYS FROM BROOD RANGE TO FALL AND WINTER RANGE IN DIFFERENT YEARS AND PREDOMINANT MAST CROP IN EACH YEAR

Year	Mast crop	Banded as poults and shot as poults				Banded as yearlings and shot as yearlings or adults		Banded as poults and shot as yearlings*	
		Male		Female		Number	Distance§	Number	Distance§
		Number	Distance§	Number	Distance§				
1969	Red oak and beech	4	0.7	3	2.3				
1970	Black cherry and ash	10	3.2	4	2.4				
1971	Beech	25	2.8	24	4.0	1	3.6		
1972	Red oak and beech	17	2.9	18	3.8	5	1.9	5	9.5
1973	Red oak	14	6.8	30	5.8	9	3.0	9	9.9
Total		70	3.3	79	3.7	8	3.9	9	17.3
						23	3.1	23	12.2

* These birds had made two fall movements and one spring movement.

§ In kilometers.

banding, had moved an average of 12.2 kilometers (Table 4). Another cohort of nine, banded as poults and shot 2 or more years later, had moved an average of 18.0 kilometers. The greater distances recorded for poults that survived more than one year reflect a combination of fall and spring movements. In the poult-to-yearling group, the birds had made two fall movements and one spring movement. The poult-to-adult group had made at least three fall and two spring movements.

The movement from brood range to fall and winter range also shows another variant. When the data for the different years (Table 4) are considered separately, it is noted that in 1973 the distance travelled from summer range to fall and winter range was about twice that in the other years. This was a year when mast production was down (Eaton, 1974) and about the only good crop was red oak acorns. This tree was much commoner in the southern part of the study area than elsewhere, and it was in the stands of red oak that most of the recoveries were made in that year.

Little specific information was obtained on the winter mortality of hens, but general observations indicated that, if a mast crop was available in a particular area, they remained in that area. If food became buried under too much snow, they often moved to spring runs until enough melting again made mast available (Eaton et al., 1970).

The toms follow the same pattern of movement as the hens from hatching until they reach juvenile status. At this time they leave the female segment of the flock and travel as a separate unit which may consist of as few as two or as many as 8 to 12 toms. Direct information on the spring movements of these birds was not obtained because none was equipped with a transmitter. However, four toms banded as poults in August and September were retrapped as yearlings at an average distance of 6.2 kilometers from where they were originally captured (Table 2).

One of these males was retrapped alone, as an adult, the next year 2.4 kilometers from where it had been encountered as a yearling. Two other toms, banded as poults and retrapped as yearlings in the fall of the following year, were killed the same fall 0.8 and 1.6 kilometers from where they had been retrapped. These recoveries again indicate, as with the hens, that the greatest movement occurs, not the first fall, but the next spring. This is further illustrated by the records summarized in Table 1 which show that toms banded as poults and killed as yearlings had travelled an average of 9.5 kilometers from their banding site and that those banded as poults and killed as adults had travelled 7.3 kilometers, whereas toms banded as poults and killed as poults had travelled only 3.5 kilometers.

Most individual birds, of either sex, that were recovered more than



Figure 3. Shortest distance and direction between point of banding and point of kill or capture for turkeys which travelled 16 kilometers or more.

16 kilometers from where they were originally banded or retrapped had travelled in either a northeasterly or southeasterly direction (Figure 3). The greatest distance recorded was that covered by a female that was banded in the study area on September 1, 1971 and killed 48 kilometers to the eastward, across the Genesee River valley, in November 1973.

DISCUSSION

The data presented here confirm what has been believed concerning the mobility of the eastern wild turkey since the work of Bailey and Rinell (1965) and Ellis and Lewis (1967). Ellis and Lewis, working in Missouri, suggested that juvenile females were the most mobile age and sex cohort in turkeys and pointed out that this has some parallels in other gallinaceous species. In their study, the toms were much more sedentary than the hens. The present study indicates that the greatest annual movement occurs in the spring. The data not only show the juvenile females to have been the most mobile, radio-tracked birds travelling an average of 16.1 kilometers from winter range to spring range, but they also suggest that the juvenile toms ranked second in mobility. Although the movement of juvenile toms was included in the distance travelled by males banded as poults and killed in their second fall as yearlings (i.e., an average of 9.5 kilometers), it is felt that most of this took place in the spring while the birds were juveniles. On the other hand, adult males and females travelled only 2.8 and 3.7 kilometers, respectively, again based on fall recoveries.

Presumably, these differences in movements of juveniles and adults reflect events taking place in the spring. The most complete behavioral study on a wild population of turkeys was made by Watts (1969) on the Welder Wildlife Refuge in Texas. He stated that "Adult males aggressively force juvenile males to disperse during the spring breeding season." Similar behavior seems to be occurring in northern populations. Watts went on to say "I do not know what factors are important in the dispersal of juvenile females based on my study." Data from the present study suggest that the adult hens are dominant in a traditional nesting area and that new individuals entering a breeding female population are forced to travel to new, unoccupied range or areas occupied by less aggressive females.

The population characteristic by which the greatest movement occurs among juvenile females and males in the spring seems to be the mechanism most responsible for the rapid range expansion that took place in northcentral Pennsylvania and southwestern New York during the late 1940's and the 1950's (Eaton, 1953; Wunz and Hayden, 1973). Wunz and Hayden stated that the species increased its range through the contiguous forest of northcentral Pennsylvania and into New York at a

TABLE 5. DEGREE OF MOVEMENT FROM PLACE OF BANDING TO PLACE OF RECOVERY FOR WILD TURKEYS IN NEW YORK COMPARED WITH DATA FOR POPULATIONS IN WEST VIRGINIA AND FLORIDA.*

Distance (kilometers)	West Virginia (387)	Florida (102)	New York			
			Total (231)	Banded as poult and shot as poult (148)	Banded as yearlings and shot as yearlings or adults (39)	Banded as poult and shot as yearlings or adults (44)
0-1.6	24	57	28 (65)	32 (48)	38 (15)	5 (2)
1.6-3.2	20	19	26 (60)	31 (46)	26 (10)	9 (4)
3.2-4.8	12	12	17 (40)	17 (25)	26 (10)	11 (5)
4.8-6.4	6	3	6 (13)	5 (8)	8 (3)	5 (2)
6.4-8.0	8	1	4 (9)	4 (6)	.. (0)	7 (3)
8.0-9.6	6	2	3 (8)	3 (4)	.. (0)	9 (4)
9.6-11.2	4	1	2 (5)	2 (3)	2 (1)	2 (1)
11.2-12.8	2	1	3 (6)	1 (1)	.. (0)	11 (5)
12.8-14.4	1	..	2 (5)	1 (1)	.. (0)	9 (4)
14.4-16.0	4	..	3 (6)	1 (2)	.. (0)	9 (4)
16.0-24.0	5	1	3 (7)	1 (2)	.. (0)	11 (5)
24.0-40.0	5	3	2 (5)	1 (2)	.. (0)	7 (3)
40.0-80.0	3	..	1 (2)	.. (0)	.. (0)	5 (2)

* Values given as percentage of recoveries.

† Figures in parentheses represent number of recoveries.

FISH INVESTIGATIONS IN LONG ISLAND SOUND AT A NUCLEAR POWER STATION SITE AT SHOREHAM, NEW YORK¹

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ABSTRACT

The shore-zone waters near a nuclear power station site on Long Island Sound at Shoreham (N.Y.) serve seasonally as a nursery ground for several species of fish, particularly the Atlantic silverside and Atlantic menhaden. The near-shore waters are important summer grounds for scup and juvenile bluefish. Chlorinated hydrocarbon and trace metal concentrations were determined in migratory (striped bass and juvenile bluefish) and resident (windowpane) fishes caught in the area and were found to be low.

In 1971 and 1972, the New York State Department of Environmental Conservation undertook a study of the fishes at a nuclear power station site on Long Island near the village of Shoreham (Figure 1). The power plant proposed for this site would use an estimated 2,271,000 liters per minute of cooling water with an increase of 11.1° to 16.7° C. above ambient temperatures (Jensen, 1970). Plans called for the heated effluent to be discharged 487 meters offshore on the bottom through a multi-port diffuser system.

The purpose of the study was to gather additional information on the species of fish found near the station site, their relative and seasonal abundance and their size ranges. It was felt that earlier biological studies of the area (Perlmutter, 1969, 1970, 1971) left gaps in the knowledge of the distribution and size of fishes of this area, particularly the larger near-shore varieties. The findings, when compared with data from ongoing studies by Long Island Lighting Company consultants and post-operational studies, should provide a baseline to assist in determining some of the environmental effects of the plant. Possible disruptions of populations and migratory patterns might be assessed.

METHODS AND MATERIALS

Three nets were used to sample the fish populations. A 91.4 by 1.8-

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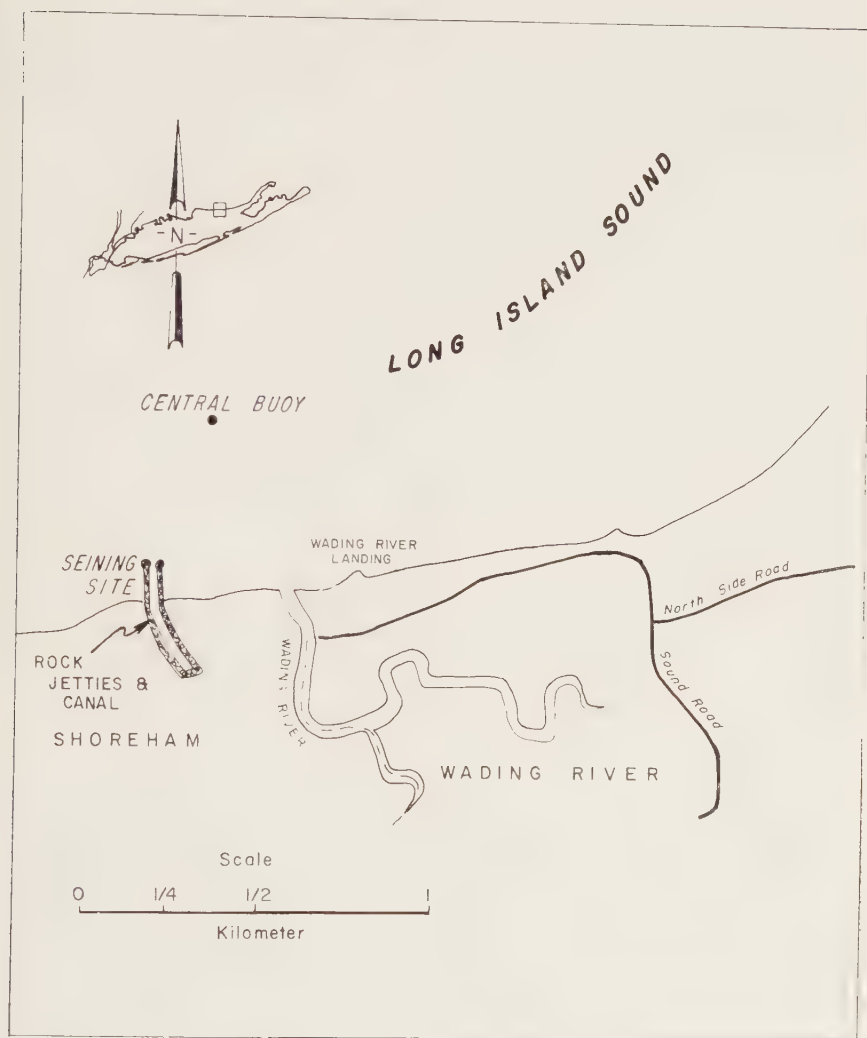


Figure 1. Map of study area showing seining site and central buoy (gill net sampling site). Inset shows location of study area in relation to the north shore of Long Island.

meter nylon haul seine was used in the shallow shore-zone (up to 2.4 meters in depth at about 30.5 meters offshore). A 396 by 3.8-meter nylon beach seine was used in the near-shore area (to a depth of about 4.3 meters about 122 meters offshore). A 152 by 3-meter nylon monofilament sinking gill net was used to sample beyond the limits of the seines (in about 5.2 meters of water in the area of the central buoy shown in Figure 1).

The 91.4-meter seine and the method of setting it were described by

Briggs and O'Connor (1971). It was set twice a month from March through October in 1972. The 396-meter seine and the method of setting it were described by Schaefer (1967). This net was set once a month from September through December in 1971 and twice a month from March through October in 1972. This schedule was dictated by available manpower. All seine hauls were made between 9:00 a.m. and 12:00 noon within an hour of slack high water. The gravel-sand beach (Figure 2) is typical of beaches on New York's shoreline of eastern Long Island Sound.

The 152-meter gill net was composed of five 30.5-meter panels of stretch mesh, i.e., one panel each of 64-millimeter, 79-millimeter, 90-millimeter, 102-millimeter and 124-millimeter mesh. It was set once in June, twice in July and twice in August in 1972.

Fish caught in the 91.4-meter seine were counted and measured to the nearest millimeter in fork length or total length depending on the conformation of the tail of the species. The larger fish, caught in the 396-meter seine or the 152-meter gill net, were counted and measured to the nearest 5 millimeters in fork length or total length. If more than 100 individuals of a species were taken in any one haul of a net, only 100 were measured. When less than 100 were taken, all were measured.

Each sample was weighed, and the average weight of an individual was computed. The entire catch of that species was then weighed and, using the average value, an approximation of the total number of indi-



Figure 2. The seining site at Shoreham.

viduals was obtained. For fish taken in the 91.4-meter seine, weights were recorded in grams. For those taken in the other two nets, weights were recorded in ounces and converted to metric values.

Each time the gear was set, the water temperature in degrees Celsius 0.3 meter below the surface was recorded, and the salinity in parts per thousand was recorded on each occasion from October 1971 through August 1972.

Logbooks were distributed to selected anglers known to fish in the study area in order to estimate the species composition of their catches.

Sub-samples from 12 whole juvenile bluefish and six whole window-panes, and fillets from two striped bass (350 and 440 millimeters in fork length), all collected on August 24, 1972, were used for analysis of pesticide (chlorinated hydrocarbons) and trace metal concentrations. Pesticide analyses were made with a gas chromatograph equipped with an electron capture detector. Metals were determined by atomic absorption spectroscopy, except that the flameless method was used for mercury.

RESULTS

A total of 40 species of fish were collected in the study area. These are listed in Table 1 according to the gear in which they were caught. The relative abundance and size composition of those caught by each gear are treated separately.

FISH TAKEN BY THE 91.4-METER SEINE

Eighteen species were caught by the 91.4-meter seine (Table 2), the greatest number being taken in August. The Atlantic silverside dominated the catch, and the Atlantic menhaden was next in abundance. Other species that contributed heavily to the catch (either over the seining season or in a given month) included bluefish, Atlantic herring, hake (sp.), American sand lance and bay anchovy.

Several species showed seasonal variations in abundance. The Atlantic silverside was the only species caught in every month of sampling. It was most abundant from July through October and was the dominant fish after July. Atlantic menhaden were caught only in midsummer, the majority being taken in a single haul on July 11, 1972 when over 90 per cent of the total catch of the species was landed. Atlantic herring, hake, American sand lance and bay anchovy were caught primarily in May and June.

The size ranges and mean lengths of the species caught by the 91.4-meter seine are shown in Table 3. Adult Atlantic silversides were caught throughout the year. However, during the summer and fall, when the largest catches of the species were made, the mean lengths indicated that juveniles were dominant. The Atlantic menhaden, hake and Amer-

TABLE 1. FISHES CAUGHT AT SHOREHAM (N.Y.) IN 1971 AND 1972 ACCORDING TO THE GEAR IN WHICH THEY WERE TAKEN

Species	Gear		
	91.4-meter seine	396-meter seine	152-meter gill net
Sooth dogfish (<i>Mustelus canis</i>)		x	x
Little skate (<i>Raja erinaceu</i>)		x	
American eel (<i>Anguilla rostrata</i>)	x		
Blueback herring (<i>Alosa aestivalis</i>)	x	x	
Hickory shad (<i>Alosa mediocris</i>)		x	
Alewife (<i>Alosa pseudoharengus</i>)		x	
American shad (<i>Alosa sapidissima</i>)		x	
Atlantic menhaden (<i>Brevoortia tyrannus</i>)	x	x	
Atlantic herring (<i>Clupea harengus harengus</i>)	x	x	
Striped anchovy (<i>Anchoa hepsetus</i>)			x
Bay anchovy (<i>Anchoa mitchilli</i>)	x	x	
Atlantic tomcod (<i>Microgadus tomcod</i>)		x	
Pollock (<i>Pollachius virens</i>)	x	x	
Hake (<i>Urophycis</i> sp.)	x		
Mummichog (<i>Fundulus heteroclitus</i>)	x		
Striped killifish (<i>Fundulus majalis</i>)	x		
Atlantic silverside (<i>Menidia menidia</i>)	x	x	
Threespine stickleback (<i>Gasterosteus aculeatus</i>)	x		
Northern pipefish (<i>Syngnathus fuscus</i>)	x	x	
White perch (<i>Morone americana</i>)		x	
Striped bass (<i>Morone saxatilis</i>)		x	
Bluefish (<i>Pomatomus saltatrix</i>)	x	x	x
Crevalle jack (<i>Caranx hippos</i>)		x	
Bigeye scad (<i>Selar crumenophthalmus</i>)		x	
Scup (<i>Stenotomus chrysops</i>)		x	x
Weakfish (<i>Cynoscion regalis</i>)		x	
Northern kingfish (<i>Menticirrhus saxatilis</i>)	x	x	x
Tautog (<i>Tautoga onitis</i>)		x	x
Cunner (<i>Tautoglabrus adspersus</i>)		x	
American sand lance (<i>Ammodytes americanus</i>)	x		
Atlantic mackerel (<i>Scomber scombrus</i>)	x	x	
Butterfish (<i>Peprilus triacanthus</i>)		x	
Northern searobin (<i>Prionotus carolinus</i>)		x	x
Striped searobin (<i>Prionotus evolans</i>)		x	x
Grubby (<i>Myoxocephalus aeneus</i>)		x	
Longhorn sculpin (<i>Myoxocephalus octodecimspinosus</i>)		x	
Summer flounder (<i>Paralichthys dentatus</i>)		x	
Windowpane (<i>Scophthalmus aquosus</i>)	x	x	x
Winter flounder (<i>Pseudopleuronectes americanus</i>)		x	
Northern puffer (<i>Sphoeroides maculatus</i>)	x	x	

ican sand lance were all juveniles. The Atlantic herring caught in April and May were young of the year. Those caught in October were probably 2 year olds, according to the age-length data given by Hildebrand (1963).

FISH TAKEN BY THE 396-METER SEINE

Thirty-two species of fish were caught by the 396-meter seine (Table 4), the greatest number being taken in October 1972. Scup dominated the catch, followed by bluefish, windowpane, Atlantic mackerel, alewife, striped bass, striped searobin, tautog and northern searobin.

TABLE 2. MONTHLY DISTRIBUTION OF FISHES CAUGHT BY 91.4-METER SEINE IN 1972

Species	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
Atlantic silverside	4	17	6	4	550	4,150	795	659	6,185
Atlantic menhaden	0	0	1	458	4,782	9	7	0	5,257
Bluefish	0	0	0	0	425	150	0	0	575
Atlantic herring	0	16	361	0	0	0	0	4	381
Hake (sp.)	0	0	0	376	0	0	0	0	376
American sand lance	0	1	120	101	0	0	0	0	222
Bay anchovy	0	0	93	0	0	0	0	0	93
Northern pipefish	0	1	0	0	11	3	7	0	22
Threespine stickleback	0	0	0	9	0	0	0	0	9
Mummichog	0	0	2	0	0	0	0	2	4
Northern puffer	0	0	0	0	0	2	2	0	4
Pollock	2	1	0	0	0	0	0	0	3
Blueback herring	0	1	0	0	0	2	0	0	3
Atlantic mackerel	0	0	0	3	0	0	0	0	3
Windowpane	0	0	0	0	0	1	0	0	1
Northern kingfish	0	0	0	0	0	1	0	0	1
American eel	0	0	0	0	0	0	1	0	1
Striped killifish	0	0	0	0	0	0	0	1	1
Total	6	37	583	951	5,768	4,318	812	666	13,141
Number of species	2	6	6	6	4	8	5	4	18

Several species showed seasonal variations in abundance. Scup totally dominated the catches in September 1971 and from July through September in 1972, but they were absent from the catches from November 1971 through June 1972. Bluefish, which were usually second only to scup in numbers caught, showed the same seasonal variations. The windowpane was the only species caught in all hauls of the 396-meter seine and comprised most of the meager catches from November 1971 through May 1972. Atlantic mackerel were caught from May through July in 1972. Alewives were prominent in the catches in October 1971 and June 1972. Striped bass were caught in October 1971 and from April through October in 1972. Striped searobins and tautog were caught in September and October in 1971 and from May through October in 1972. Other frequently caught fishes and the times of their greatest abundance were the northern searobin (September and October in 1971 and from June through October in 1972) and winter flounder (September and November in 1971 and from March through July and in October in 1972).

The size ranges and mean lengths for the species caught by the 396-meter seine are shown in Table 5. The scup appeared to be mostly 2- or 3-year-old fish according to the age-length data given by Finkelstein (1969). The bluefish were mostly young of the year. The windowpanes were almost all adults. The Atlantic mackerel caught in May and June in 1972 were all adults, but the large numbers caught in July 1972 were all young of the year. Most of the alewives were small. The striped bass ranged from apparently 2-year-old fish to adults.

TABLE 3. SIZE DISTRIBUTION, BY MONTH, OF FISHES CAUGHT BY 91.4-METER SEINE IN 1972*

Species	March		April		May		June	
	Range§	Mean	Range§	Mean	Range§	Mean	Range§	Mean
Atlantic silverside	57-105	78	60-115	83	85-100	92	12-84	48
Atlantic menhaden	..	..	..	..	55	55	12-25	20
Bluefish	..	..	..	..	..	..	..	..
Atlantic herring	..	..	30-45	34	32-61	42	..	..
Hake (sp.)	..	..	..	..	..	..	..	..
American sand lance	..	..	36	36	31-56	43	13-41	25
Bay anchovy	..	..	..	..	59-90	69	45-80	65
Northern pipefish	..	..	100	100	..	..	..	..
Threespine stickleback	..	..	..	..	..	..	17-25	21
Mummichog	..	..	..	..	52-55	54	..	..
Northern puffer	..	..	..	..	..	..	..	..
Pollock	30-34	32	31	31	..	..	..	..
Blueback herring	..	..	55	55	..	..	..	..
Atlantic mackerel	..	..	..	..	..	..	..	..
Windownpane	..	..	..	..	..	..	16-21	19
Northern kingfish	..	..	..	..	..	..	..	..
American eel	..	..	..	..	..	..	..	..
Striped killifish	..	..	..	..	..	..	..	..

TABLE 3. (continued)

Species	July		August		September		October	
	Range§	Mean	Range§	Mean	Range§	Mean	Range§	Mean
Atlantic silverside	10-130	45	15-125	47	35-130	63	30-160	91
Atlantic menhaden	15-35	23	30-40	33	25-50	38	..	..
Bluefish	66-120	82	80-170	125	..	..	130-220	190
Atlantic herring	..	..	..	..	..	..	..	..
Hake (sp.)	..	..	..	..	..	..	..	..
American sand lance	..	..	..	..	..	..	..	..
Bay anchovy	..	..	..	..	..	..	..	..
Northern pipefish	40-55	50	60-95	72	60-170	114	..	..
Threespine stickleback	..	..	..	..	..	..	..	..
Mummichog	..	..	..	..	..	..	..	..
Northern puffer	..	..	10	10	15	15	40	40
Pollock	..	..	..	..	..	..	..	..
Blueback herring	..	..	125-140	133	..	..	..	..
Atlantic mackerel	..	..	..	..	..	..	..	..
Windowpane	..	..	325	325	..	..	..	..
Northern kingfish	..	..	70	70	..	..	..	..
American eel	..	..	..	..	50	50	..	..
Striped killifish	..	..	..	..	..	..	100	100

* In millimeters; species with forked tails measured to fork length, all others to total length.

§ Single numerals represent the length of the one specimen measured.

TABLE 4. MONTHLY DISTRIBUTION OF FISHES CAUGHT BY 396-METER SEINE FROM SEPTEMBER 1971 TO OCTOBER 1972

Species	Sept.	Oct.	Nov.	Dec.	March	April	May	June	July	Aug.	Sept.	Oct.	Total
Scup	1,147	30	0	0	0	0	0	0	2,052	8,987	9,635	256	22,107
Bluefish	40	683	0	0	0	0	0	0	10	1,900	124	182	2,939
Windowpane	5	42	8	2	43	53	190	64	24	41	28	60	560
Atlantic mackerel	0	0	0	0	0	0	5	24	339	0	0	0	368
Alewife	0	74	0	0	0	1	6	129	0	0	0	0	210
Striped bass	0	68	0	0	0	2	9	33	29	26	21	11	199
Striped searobin	5	2	0	0	0	0	6	73	62	14	7	8	177
Northern searobin	37	13	0	0	0	0	0	2	27	55	27	9	170
Tautog	10	59	0	0	0	0	21	31	6	4	31	4	166
Northern kingfish	0	3	0	0	0	0	0	0	55	0	1	5	64
Blueback herring	0	0	0	0	0	0	12	0	0	3	0	43	58
Atlantic menhaden	24	19	0	0	0	0	1	0	0	2	0	4	50
Hickory shad	0	19	0	0	0	0	0	15	0	0	0	2	36
Winter flounder	1	0	2	0	6	7	11	5	1	0	0	2	35
Cunner	0	0	0	0	0	0	1	24	8	1	1	0	35
Smooth dogfish	0	1	0	0	0	0	0	0	5	19	0	0	27
Little skate	0	0	0	0	0	0	8	0	0	0	0	4	12
Butterfish	0	7	0	0	0	0	0	0	0	1	0	1	9
Longhorn sculpin	0	0	0	0	1	7	1	0	0	0	0	0	9
Weakfish	0	6	0	0	0	0	0	2	0	0	0	0	8
Crevalle jack	1	2	0	0	0	0	0	0	0	0	0	1	4
Pollock	0	0	0	0	0	0	0	4	0	0	0	0	4
Northern pipefish	0	0	0	0	0	0	0	2	0	2	0	0	4
White perch	0	0	0	0	2	0	0	0	0	0	0	1	3
Northern puffer	1	0	0	0	0	0	0	0	0	1	0	0	2
Atlantic silverside	0	1	0	0	0	1	0	0	0	0	0	0	2
Bay anchovy	0	0	0	0	0	0	2	0	0	0	0	0	2
Grubby	0	0	0	0	0	0	0	2	0	0	0	0	2
American shad	0	0	0	0	0	0	0	1	0	0	0	1	2
Summer flounder	0	0	0	0	0	0	0	1	0	1	0	0	2
Bigeye scad	1	0	0	0	0	0	0	0	0	0	0	0	1
Atlantic tomcod	0	0	0	0	0	0	0	1	0	0	0	0	1
Total	1,272	1,029	10	2	52	71	273	413	2,618	11,057	9,875	596	27,268
Number of species	11	16	2	1	4	6	13	17	12	15	9	18	32

TABLE 5. (continued)

Species	May		June		July		August		September		October	
	Range§	Mean	Range§	Mean	Range§	Mean	Range§	Mean	Range§	Mean	Range§	Mean
Scup	..	..	..	..	100-150	123	115-215	138	135-190	161	150-185	166
Bluefish	..	..	..	..	120-135	127	130-185	161	155-195	173	165-210	187
Windowpane	230-365	285	230-305	297	253-310	276	225-335	292	155-360	278	210-355	282
Atlantic mackerel	355-450	392	325-405	356	90-125	105	..	..	..	..	..	..
Alewife	120-320	205	125-230	145	..	..	..	..	..	..	..	..
Striped bass	240-555	319	235-740	370	260-750	367	290-420	352	375-600	438	330-615	415
Striped searobin	310-475	364	255-435	344	280-440	366	325-440	355	220-445	313	325-435	388
Tautog	120-380	408	75-315	315	135-460	303	135-165	152	115-540	192	175-410	271
Northern searobin	..	..	235-325	290	235-340	281	180-355	273	275-350	316	310-355	330
Northern kingfish	..	..	..	..	255-290	266	..	..	75	75	295-325	311
Blackback herring	95-145	130	..	..	..	..	155-160	157	..	..	150-260	168
Atlantic menhaden	320	320	..	..	..	..	320-335	328	..	..	320-340	330
Hickory shad	..	..	110-150	128	..	..	..	..	..	..	225-330	278
Winter flounder	100-380	273	200-245	229	235	235	..	..	..	..	150-185	168
Cunner	160	160	80-185	147	105-175	150	..	..	180	180	..	..
Smooth dogfish	..	..	..	..	315-420	374	380-455	414	..	..	450-520	445
Little skate	370-450	437	..	..	..	..	..	..	..	..	420-475	486
Butterfish	..	..	..	..	..	..	170	170	..	..	70	70
Longhorn sculpin	290	290	..	..	..	..	..	..	..	..	..	..
Weakfish	..	..	455-495	475	..	..	..	..	..	..	..	..
Creville jack	..	..	..	..	..	..	..	..	..	..	120	120
Pollock	..	..	115-150	134	..	..	..	..	..	..	..	..
Northern pipefish	..	..	160-175	168	..	..	145-170	158	..	..	..	..
White perch	..	..	..	..	..	..	..	..	..	..	210	210
Northern puffer	..	..	..	..	..	..	..	..	..	..	..	..
Atlantic silverside	..	..	..	..	..	..	140	140	..	..	..	..
Bay anchovy	..	..	..	..	..	..	..	..	..	..	..	..
Grubby	70- 75	73	..	..	..	..	..	..	..	..	..	..
American shad	..	..	75-120	98	..	..	..	..	..	..	..	..
Summer flounder	..	..	395	395	..	..	..	..	..	..	510	510
Bigeye scad	..	..	365	365	..	..	395	395	..	..	..	..
Atlantic tomcod	..	..	340	340	..	..	..	..	..	..	..	..

* In millimeters; species with forked tails measured to fork length, all others to total length.

§ Single numerals represent the length of the one specimen measured.

TABLE 6. WEIGHT (IN KILOGRAMS) OF FISHES CAUGHT IN 396-METER SEINE IN 1972, BY MONTH

Species	March	April	May	June	July	August	September	October	Total
Scup	..	..	..	..	80.3	671.6	839.3	27.2	1,618.4
Bluefish	12.4	..	..	..	0.4	105.6	9.1	16.8	131.9
Windowpane	..	16.0	48.9	15.7	5.4	10.5	6.3	13.8	129.0
Striped bass	..	1.5	5.0	28.1	27.1	15.6	23.0	10.3	110.6
Striped searobin	..	..	3.5	40.6	30.5	7.7	3.6	7.0	92.9
Tautog	..	..	36.4	31.4	5.6	0.4	7.9	2.5	84.2
Northern searobin	..	..	..	0.5	5.3	10.8	8.2	3.1	27.9
Atlantic mackerel	..	..	3.5	11.4	4.6	..	..	..	19.5
Northern kingfish	..	..	..	..	9.3	..	<0.1	1.6	<11.0
Winter flounder	2.4	2.9	3.5	0.9	0.1	..	..	0.2	10.0
Smooth dogfish	..	..	..	..	1.0	5.2	..	0.9	7.1
Alewife	..	0.2	1.0	5.3	..	..	..	..	6.5
Little skate	..	..	4.0	..	..	..	..	..	6.2
Atlantic menhaden	..	..	0.6	..	..	1.6	..	2.2	4.6
Longhorn sculpin	0.4	2.4	0.4	..	..	..	..	2.4	3.2
Blueback herring	..	..	0.3	..	..	0.2	..	..	2.9
American shad	..	..	..	0.9	..	..	..	1.6	2.5
Cunner	..	..	..	1.4	0.5	0.1	0.1	..	2.2
Weakfish	..	..	0.1	2.0	..	..	..	..	2.0
Summer flounder	..	..	..	0.5	..	0.7	..	..	1.2
Hickory shad	..	..	..	0.5	..	..	..	0.5	1.0
Atlantic tomcod	..	..	..	0.4	..	..	..	..	0.4
White perch	0.1	..	..	..	..	..	..	0.2	0.3
Butterfish	..	..	..	..	..	<0.1	..	<0.1	<0.2
Pollock	..	..	..	0.1	..	..	..	<0.1	0.1
Crevalle jack	..	..	..	..	..	..	..	<0.1	<0.1
Grubby	..	..	..	<0.1	..	..	..	..	<0.1
Northern puffer	..	..	..	..	..	<0.1	..	..	<0.1
Northern pipefish	..	..	..	<0.1	..	<0.1	..	..	<0.1*
Atlantic silverside	..	<0.1	..	..	..	..	..	..	<0.1
Bay anchovy	..	..	<0.1	..	..	..	..	..	<0.1
Total	15.3	23.1	107.3	139.9	170.1	830.3	379.6	92.9	2,276.4*

* For the northern pipefish, the combined weight of those taken in June and August was less than 0.1 kilogram. Therefore, the total weight for this species and that for all species are less than the sum of the monthly values.

TABLE 7. NUMBER AND SIZE OF FISHES CAUGHT BY 152-METER GILL NET IN 1972

Species	June			July			August		
	Number	Size*		Number	Range§	Mean	Number	Range§	Mean
		Range§	Mean						
Northern searobin	1,140	240-360	294	35	200-300	270	21	215-335	297
Striped searobin	23	260-370	335	13	280-440	345	22	255-415	337
Scup	0	..	..	6	130-215	173	10	125-260	164
Bluefish	0	..	..	1	485	485	10	320-490	359
Windowpane	6	215-275	247	1	220	220	1	250	250
Northern kingfish	0	..	..	2	250-280	265	6	250-275	263
Smooth dogfish	0	..	..	0	..	..	3	375-975	653
Tautog	0	..	..	2	215-285	250	0	..	..
Striped anchovy	0	..	..	1	105	105	0	..	..

* In millimeters; species with forked tails measured to fork length, all others to total length.

§ Single numerals represent the length of the one specimen measured.

The windowpane dominated the catches by weight from March through May in 1972 (Table 6), but in June the striped searobin was the dominant species. From July through October in 1972, scup dominated the catches by weight, well over half a metric ton being taken in both August and September. Other species that comprised major portions of the catch by weight included bluefish, striped bass and tautog.

FISH TAKEN BY THE 152-METER GILL NET

Relatively few fishes were caught by the gill net, except for a large catch of northern searobins in June (Table 7). The searobins, scup and bluefish made up most of the catch by this net. Except for the bluefish, which were all adults, the sizes of the fish caught in the gill net were comparable to those of the fishes caught by the 396-meter seine.

TEMPERATURE AND SALINITY

Water temperatures rose from less than 5° C. in March to summer levels in the low 20's by mid-July (Figure 3), while seasonal declines began in mid-September. The lowest temperature recorded during the study was 2.2° C. on March 13, 1972. On that date, only five windowpanes and one longhorn sculpin were caught (in the 396-meter seine). The highest temperature recorded was 24.6° C. on July 25, 1972. On that

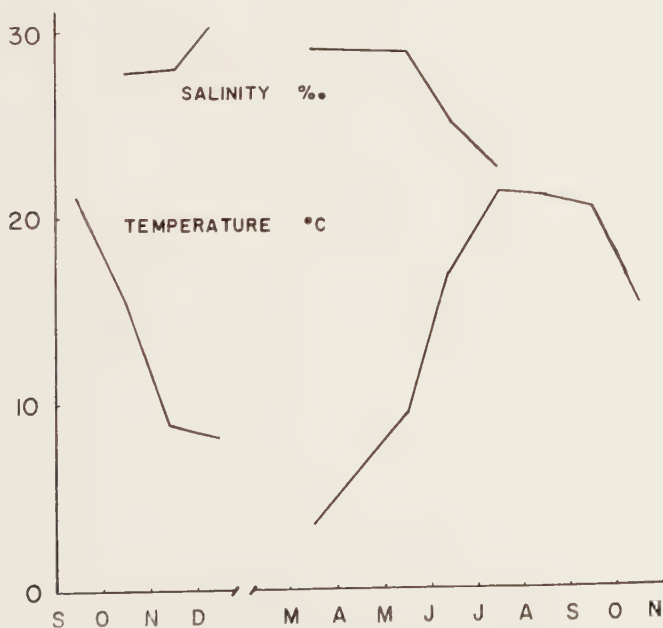


Figure 3. Temperatures and salinities at the seining site, September 1971 to October 1972.

date, the first (and largest: 425) catch of juvenile bluefish was made with the 91.4-meter seine.

Salinities ranged from 22.4 to 30.4 ppt. Seasonal variations are plotted in Figure 3.

ANGLING

Anglers were seen fishing from jetties adjacent to the seining sites and also from boats within the areas sampled by the 396-meter seine and the gill net. Those who returned logbooks caught mostly Atlantic mackerel and striped bass in the spring, bluefish in the summer and striped bass and bluefish in the fall. Only 18 per cent of the striped bass caught from the jetties and only 24 per cent of those caught from boats in the area equalled or exceeded New York's minimum legal size of 16 inches (406 millimeters) in fork length. Other fish that these selected anglers caught included smooth dogfish, searobins, tautog, windowpane, winter flounder, longhorn sculpin, weakfish and scup.

PESTICIDES AND TRACE METALS

Pesticide (chlorinated hydrocarbons) and trace metal concentrations in migratory (striped bass and juvenile bluefish) and resident (windowpane) fishes collected on August 24, 1972 are shown in Tables 8 and 9. Pesticide levels in juvenile bluefish were similar to those found by

TABLE 8. PESTICIDE CONCENTRATIONS IN FISHES FROM THE SHOREHAM AREA*

Species	DDE	DDD	DDT	Dieldrin
Bluefish	0.033	0.052	0.045	0.021
Striped bass	0.027	0.037	0.026	tr
Windowpane	0.023	0.026	0.036	0.010

* In milligrams per kilogram of wet weight; "tr" = trace, i.e., greater than 0.007, but less than 0.010.

TABLE 9. TRACE METAL CONCENTRATIONS IN FISHES FROM THE SHOREHAM AREA*

Species	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Zn
Bluefish									
Wet weight	0.466	0.995	0.498	2.92	2.71	0.043	1.75	2.36	17.3
Dry weight	1.14	2.44	1.22	7.17	66.6	0.106	4.3	5.8	42.5
Striped bass									
Wet weight	0.249	0.409	0.613	2.80	8.36	0.105	0.265	1.45	5.49
Dry weight	0.796	1.31	1.96	8.95	26.7	0.335	0.847	4.63	17.5
Windowpane									
Wet weight	0.285	0.821	0.386	3.12	18.8	0.099	6.85	1.17	22.4
Dry weight	1.14	3.28	1.54	12.8	75.2	0.396	27.4	4.68	89.6

* In milligrams per kilogram.

Foehrenbach (1972) in specimens of this species from Flanders Bay. The levels in striped bass and windowpanes were slightly lower than those in juvenile bluefish. Foehrenbach (1972) noted that the levels he found in fish were "much lower than the limits set for shellfish by the U.S. Food and Drug Administration. Their limits are 1.5 mg. of the sum total of any combination of DDT, DDD, or DDE and 0.3 mg. of dieldrin/kg. of shellfish meat."

Concentrations of cobalt, nickel and zinc fell within the ranges found by Tong et al. (1972) for freshwater fish in New York State. The levels of cadmium were higher. Tong et al. (1972) did not consider the levels of trace metals they found in fish to be hazardous to the consumer. Indeed, they stated that they were "probably desirable from a nutritional standpoint".

The levels of mercury in the fish tested from Shoreham were well below that of 0.5 milligram per kilogram which has been established by the U.S. Food and Drug Administration as the "actionable level". Fish exceeding the actionable level may not be offered for sale commercially and are not recommended for human consumption.

DISCUSSION AND CONCLUSIONS

Long Island Sound at Shoreham (N.Y.) supports a wide variety of shore-zone and near-shore fishes. The shore zone appears to be seasonally a nursery ground for several species. In May, juvenile Atlantic herring and American sand lance were plentiful. Juvenile Atlantic menhaden were abundant in June and July. Juvenile Atlantic silversides first appeared in July and remained abundant through October. The relative abundance and size composition of the shore-zone fishes were generally similar to those found by Perlmutter (1969, 1970, 1971).

The near-shore area (up to about 122 meters from shore) appears to be an important summer area for scup and juvenile bluefish. Other abundant migrants included searobins and striped bass. The most common resident fish was the windowpane. Many of the predatory species in this area were probably attracted by the abundance of small forage fishes in the nearly shore zone.

Anglers were active in the area and harvested Atlantic mackerel, striped bass, bluefish and other species.

Specimens of the two migratory (striped bass and juvenile bluefish) and one resident (windowpane) species examined showed low concentrations of DDT and its metabolites, dieldrin and trace metals.

In order to minimize the effect of power station operation on the fish populations in the vicinity, certain precautions should be taken. The temperature of used cooling water discharged into Long Island Sound should not exceed the standards put forth by the State Department of

Environmental Conservation. Shut downs for normal maintainance should be scheduled at times other than during the winter months so that fish in the thermal plume will not be killed by the sudden cold. Treatment of cooling water with chlorine compounds to prevent fouling the cooling water system has caused fish kills at the discharge of power plants and has lowered primary productivity in such areas (Fairbanks et al., 1971; Hamilton et al., 1970). Therefore, such use of chlorine-bearing compounds should be undertaken with caution. The recommendations of Fairbanks et al (1971) that "residual chlorine levels in discharge water be maintained at or below 0.1 ppm" are considered appropriate. Post-operational studies would be desirable to determine what changes, if any, in the fish fauna of the area may occur.

LITERATURE CITED

- BRIGGS, PHILIP T., and JOEL S. O'CONNOR. 1971. Comparison of shore-zone fishes over naturally vegetated and sand-filled bottoms in Great South Bay. N.Y. Fish and Game Jour. 18(1):15-41.
- FAIRBANKS, RANDALL B., W. STEPHEN COLLINGS and WENDALL T. SIDES. 1971. An assessment of the effects of electrical power generation on marine resources in the Cape Cod Canal. Mass. Dept. Nat. Res., Div. Mar. Fish.
- FINKELSTEIN, SAMUEL L. 1969. Age and growth of scup in the waters of eastern Long Island. N.Y. Fish and Game Jour. 16(1):84-110.
- FOEHRENBACH, JACK. 1972. Chlorinated pesticides in estuarine organisms. Jour. Water Poll. Control Fed. 44(4):619-624.
- HAMILTON, D. H., JR., D. A. FLEMER, CAROLYN W. KEFFE and J. A. MIHURSKY. 1970. Power plants: effects of chlorination on estuarine primary productivity. Science 169:197-198.
- HILDEBRAND, SAMUEL F. 1963. Family Clupeidae. In: Fishes of the Western North Atlantic (H. B. Bigelow, Editor in Chief). Sears Found. Mar. Res., Yale Univ.:257-454.
- JENSEN, ALBERT C. 1970. Thermal loading in the marine district. N.Y. Fish and Game Jour. 17(2):65-80.
- PERLMUTTER, ALFRED. 1969. Ecological study 1968 Shoreham nuclear power station. Long Island Lighting Co.
- . 1970. Ecological study 1969 Shoreham nuclear power station. Long Island Lighting Co.
- . 1971. Ecological study of the aquatic environs of the proposed nuclear power station of the Long Island Lighting Company at Shoreham: 1970-1971 and summary, 1968-1971. Long Island Lighting Co.
- SCHAEFER, RICHARD H. 1967. Species composition, size and seasonal abundance of fish in the surf waters of Long Island. N.Y. Fish and Game Jour. 14(1):1-46.
- TONG, S. C., WALTER H. GUTEMANN, DONALD J. LISK, GEORGE BURDICK and EARL HARRIS. 1972. Trace metals in New York State fish. N.Y. Fish and Game Jour. 19(2):123-131.

OBSERVATIONS ON STEEP-SLOPE DEER WINTERING AREAS IN NEW YORK AND VERMONT¹

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ABSTRACT

In the eastern foothills of the Adirondacks in New York and the eastern foothills of Vermont, as well as along the west face of the Green Mountains, deer were found to use steep south-, southwest- or west-facing slopes as winter concentration areas in preference to lowland coniferous cover. Observations indicated that such slopes are favorable because snow accumulation is less due to the steepness, snow is blown off by prevailing winds and dissipation is greater since the slope faces into the sun. Although such wintering areas are atypical with respect to deer in the Northeast generally, these observations illustrate the ability of the white-tailed deer to adapt to different topographic, climatic and vegetational conditions. Where it occurs, use of such areas must be recognized to avoid misinterpretation of range requirements and relative population levels.

The common concept of winter range of the white-tailed deer (*Odocoileus virginianus*) in the Northeast involves areas that include mature softwood stands situated at lower elevations and generally oriented along watercourses. In some cases, winter concentration areas are situated along the lower portions of south-facing slopes, especially where a softwood border is present. This type of winter range has been described by Severinghaus and Cheatum (1956), Banasiak (1961) and many others.

While there is no question that these are valid generalizations for the Northeast, it has been found that they do not hold true in all localities. Recent field work in New York and Vermont has revealed deer wintering areas in situations of a type not previously recognized. Overemphasis on the belief that deer always move from higher to lower elevations with the onset of winter or that the tops of mountains are not suitable sites may result in misinterpretation of range requirements and relative population levels. This paper presents some of the findings of this recent work and describes what might be considered atypical winter range.

During 1969 and the early 1970's, as part of a deer inventory and problem analysis, winter aerial and ground surveys of the eastern foothills of the Adirondacks were made to locate existing deer win-

¹The observations in New York were made while the author was employed by the New York State Department of Environmental Conservation prior to moving to Vermont. Gary Parsons of that Department, Lawrence Garland of the Vermont Agency of Environmental Conservation and William Hesselton of the U.S. Fish and Wildlife Service assisted by reviewing the manuscript and offering comments.

tering areas as an aid in understanding range problems. Since there was a lack of information regarding the location and nature of the winter range in this section, complete coverage was undertaken until definite patterns were recognized. Preconceived ideas on where to look for deer were avoided. As it turned out, this was a wise procedure.

The Adirondack foothills, as referred to in this paper and described by Dickinson (1969), involves a fairly narrow strip of land between the central Adirondacks and the Lake Champlain-Hudson River valley. Proceeding eastward from the central Adirondacks, one enters this section near the 1,400-foot contour of elevation. The topography consists primarily of hills and rounded mountains and is characteristically rolling to moderately rough. Average annual snowfall is between 60 and 80 inches, with maximum snow depths over 2 feet being common. While spruce-fir-northern hardwood forests are typical of the central Adirondacks, many of the more southerly tree species such as red oak (*Quercus rubra*), white oak (*Quercus alba*), hickories (*Carya* spp.) and black birch (*Betula lenta*) are components of the woodlands in the eastern foothills. Probably the most conspicuous tree species is the white pine (*Pinus strobus*). In addition, a greater variety of shrubs occurs with witch hazel (*Hamamelis virginiana*), leatherwood (*Dirca palustris*), maple-leaved viburnum (*Viburnum acerifolium*) and ground juniper (*Juniperus communis*) being common (Dickinson, 1969).

Following several hours of systematic aerial survey of all topographic features and cover types in northeastern Warren County in February 1969, a pattern of deer distribution began to be evident. At first, practically no sign of deer activity was observed in situations where it was to be expected, including many low-lying softwood areas containing red spruce (*Picea rubens*), balsam fir (*Abies balsamea*), white pine and hemlock (*Tsuga canadensis*). Then, major deer concentrations were located on Bloomer, Catamount, Black and Tongue Mountains which are situated on either side of Lake George in the towns of Bolton, Dresden and Hague. Subsequent ground cruises substantiated these findings, and similar concentrations were located on other mountains such as Three Brothers, Park and Number Eight near Brant Lake in the town of Horicon.

The deer definitely were not wintering in the low-lying softwood cover as might be expected, but appeared to have moved uphill to winter. The common denominator of the foothill wintering areas seemed to be very steep south-, southwest- or west-facing slopes, many of which exhibited an abundance of ledges. At first these sites might not appear to be favorable places for deer to winter, but, when one recognizes that movement



The eastern slope of Three Brothers Mountain in the Town of Horicon (N.Y.) in early March 1969. Winter deer activity extended up over all three peaks.



The south slope of Bloomer Mountain the Town of Hague (N.Y.) in early March 1969. Bare ground was common on south slopes much of the winter.

to wintering areas is primarily a response to deepening snows that impede travel, the selection is quite logical. Deer seek out the areas where they can find the greatest relief from deep snows. As a result of the slope and aspect in the situations chosen, snow depths are minimized. Snow accumulation is less because of the steepness, snow is blown off by prevailing winds and dissipation is greater since the slope faces into the sun. It was quite common, especially during the latter half of the winter, to see an abundance of bare ground on these slopes when the north-facing slopes and flats were covered with over 2 feet of snow. This pattern of winter deer movement and activity reflected the response of the deer to the particular physiographic conditions of topography, climate and vegetation in that locality.

These steep south- and southwest-facing slopes have shallow soils, are very rocky and characteristically support red oak, white oak, hop hornbeam (*Ostrya virginiana*), shagbark hickory (*Carya ovata*), shadbush (*Amelanchier* sp.), staghorn sumac (*Rhus typhina*) and ground juniper. Although these slopes are exposed to the wind, deer usually can, in a matter of minutes, travel up over the tops of the mountains or through saddles to find protection from it. The north slopes of such wintering areas generally possess an abundance of hemlock and white pine. With respect to relative elevations, examples may be noted. Lake George is



The south slope of Mount Ascutney in the Town of Weathersfield (Vt.) in April 1974. Softwood on top is heavy to stunted spruce. Deer wintered to a point well over two-thirds of the way up the slopes.

less than 400 feet above sea level, while the top of Bloomer Mountain is over 1,700 feet. The elevation of Brant Lake is about 800 feet, while the top of Three Brothers is close to 2,000 feet and that of Park Mountain is over 1,900 feet. Generally, the higher up the slope, the heavier the degree of deer browsing observed. In the case of Three Brothers, evidence of heavy winter deer activity was not noticeable below 1,000 feet.

Ground surveys during the winters of 1972-73 and 1973-74 in the eastern foothills of Vermont revealed that the winter range used by deer was similar to that in the Adirondack foothills. The lower elevations, even when they possessed abundant softwood shelter, tended to be avoided, with the deer usually being found on the steeper south-, southwest- and west-facing slopes. Gentler slopes were used, but the steeper ones seemed to be much more attractive. Again, deer were found to be moving uphill to winter.

The eastern foothills of Vermont are situated between the Green Mountains and the Connecticut River and extend northward from the Massachusetts border into Orange County. The topography is quite rugged with an abundance of steep slopes. The average snowfall ranges from 70 to 100 inches, and the average seasonal maximum depth on the ground is over 20 inches (Dickinson and Garland, 1974). A review of snow-cover surveys revealed that, during probably a third of the winters, maximum depths exceeded 30 inches and occasionally exceeded 40 inches. Such conditions force deer into definite winter concentrations. The vegetation is similar to that of the Adirondack foothills, although one major difference is that balsam fir and red spruce are not common.

The Mount Ascutney area in the towns of Weathersfield and Windsor is one example of winter deer range in the eastern foothills. The base of the mountain is about 500 feet above sea level, while the summit is over 3,100 feet. Heavy winter deer activity was observed well over the 2,000-foot elevation, with most of the steep south face being used. The slopes support stands of oak and associated hardwoods and are interspersed with stands of hemlock and white pine and bare ledges. The least evidence of past browsing was found at the lower elevations.

Other examples of steep-slope wintering areas in the eastern foothills are: the West River winter range complex which extends from South Londonderry to Townshend in the towns of Londonderry, Jamaica and Townshend; Peaked Mountain in the town of Townshend; Deer Hill in the town of Newfane; Black Mountain in the town of Dummerston; and Round and Richardson Mountains in the town of Brattleboro. All of these characteristically have steep, rocky south- and southwest-facing slopes that support an abundance of oak. Hemlock is found on the north-facing slopes and also in draws and on wet benches interspersed among the hardwoods. It was generally observed that the higher up the slope,

the heavier the degree of deer browsing. With respect to elevations: the West River is about 500 feet above sea level, while winter deer activity was noted up to 1,700 feet on adjacent slopes; Black Mountain ranges from 400 feet at its base to over 1,200 at the top; and Richardson Mountain ranges from 600 feet to nearly 1,200 feet.

There are periods during the winter when deer activity patterns may differ from those described. This is true in both the Adirondack foothills of New York and the eastern foothills of Vermont. If snow accumulations much in excess of 1 foot develop in December or early January, even the steeper slopes may have enough snow to discourage deer activity. As a result of the position of the sun, the likelihood of snow being dissipated from such slopes is poorest during early winter. Consequently, the slopes will be most attractive during the latter part of the winter. In both states, fairly heavy deer activity has been noted near the base of such slopes and on adjacent flats during early winter. However, as winter progresses, it drops off sharply. Evidence of past-year browsing indicated that such use is short-termed.

Steep-slope wintering areas also occur along the western face of the Green Mountains. Evidence of heavy winter deer concentrations was noted part way up the slope at many locations. One example is the Lye Brook Slopes area near Manchester in the towns of Manchester and Sunderland where the base of the slope is about 700 feet above sea level.



The western face of the Green Mountains near Manchester (Vt.) in late March 1973. Winter deer activity extended nearly to the tops of the slopes.

Heavy deer activity began at about 1,200 feet and extended to over 2,300 feet. Another is the Green Mountain area near Danby in the town of Mt. Tabor where there was evidence of heavy winter activity from 1,000 feet up the steep slopes to the top which is near the 2,300-foot mark. The steep west-facing slopes in these localities, which resulted geologically from the northwest thrust of the mountains (Jacobs, 1950), apparently do not intercept as much snow as the interior of the Green Mountains, and accumulations are minimized. A combination of steep slopes laced at intervals with bands of hemlock shelter and an abundance of striped maple (*Acer pennsylvanicum*) and witch hobble (*Viburnum alnifolium*) make these sites very favorable for winter deer occupation.

These observations in the two states further illustrate the ability of the white-tailed deer to adapt to different topographic, climatic and vegetational conditions.

LITERATURE CITED

- BANASIAK, CHESTER F. 1961. Deer in Maine. Game Div. Bull. No. 6. Maine Dept. Inland Fish. and Game.
- DICKINSON, NATHANIEL R. 1969. Planning fish and wildlife programs, Region 6—Fulton, Hamilton, Saratoga, Warren and Washington Counties. Div. Fish and Wildl., N.Y.S. Cons. Dept. (mimeo.)
- DICKINSON, NATHANIEL R., and LAWRENCE E. GARLAND. 1974. The white-tailed deer resource of Vermont. Vermont Fish and Game Dept. (mimeo.)
- JACOBS, ELBRIDGE C. 1950. The physical features of Vermont. Vermont State Develop. Dept., Vermont Geol. Surv.
- SEVERINGHAUS, C. W., and E. L. CHEATUM. 1956. Life and times of the white-tailed deer. In: The Deer in North America [W. P. Taylor, Ed.]. The Stackpole Co., Harrisburg, Pa.

DISTRIBUTION AND ABUNDANCE OF ICHTHYOPLANKTON IN THE NEW YORK BIGHT DURING THE FALL IN 1971¹

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New York Ocean Science Laboratory²

ABSTRACT

Sampling for phytoplankton, zooplankton, water chemistry and physical parameters was conducted at a series of stations in the New York Bight in September and November of 1971. The relationships of the finfish eggs and larvae collected to the associated oceanographic conditions are discussed in terms of the sources of the parent stocks and the time and place of spawning. The bulk of the spawning that occurs in coastal New York waters is by migratory stocks, the principal species in the New York Bight being the menhaden, anchovy, weakfish, mackerel and searobin.

The New York Bight is coming into ecological focus after decades of neglect. As a coastal area it is of potential importance as a spawning or nursery ground for many species of fish, yet documentation for much of this is lacking. Early faunal studies such as those of Breder (1938) were strictly qualitative and lacked information on the early pelagic life forms. More recent studies, such as those by Coker (1965), Perlmutter et al. (1967) and the National Marine Fisheries Service (1972a, 1972b) either included discussions of the early life stages from adjacent regions or, if in the Bight, made no mention of eggs, larvae or juvenile stages. Perlmutter (1939) in his comprehensive study of Long Island's marine waters in 1938 sampled in the Bight but his samples were not quantified. The current scientific focus on the Bight is the result of a shift in awareness to its environmental problems and the increasing consideration of its use as a site for offshore structures such as power plants, jet ports and deep-sea tanker facilities. The present study was undertaken as part of an initial feasibility study for the Federal Aviation Administration in its consideration of the New York Bight as a possible site for an offshore jet port.

METHODS AND MATERIALS

Sampling for phytoplankton, zooplankton, water chemistry and physical parameters was conducted in the fall of 1971 at a series of stations in the New York Bight (Figure 1). Stations 1-4 were occupied sequentially three times on September 9, and Stations 1-3 and 5 were occupied simi-

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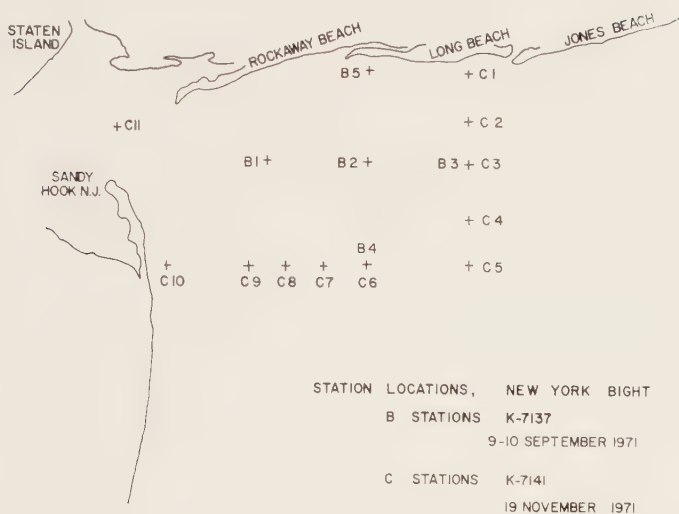


Figure 1. Location of stations in the New York Bight where sampling was conducted.

larly on September 10. Zooplankton samples were collected at the surface and below the thermocline. Thermocline topography was ascertained by a bathythermograph cast immediately prior to the net cast.

Stations 1-5 were occupied each once on November 17, and on November 19 a transect of 11 stations (C1-C11) was run using both a surface net and a deeper net as in September. Since the water column was not stratified, the nets were spaced to give the greatest possible coverage along the transect (i.e., if a net was fished at 20 meters at one station, it was fished at 10 meters at the next).

Plankton was collected only at those stations where there were coincident physical-chemical measurements. Collections were made with metered $\frac{3}{4}$ -square-meter 363-micron-mesh nets. Subsurface tows were made with the opening-closing double-trip mechanism described by Niskin and Jones (1963). All samples were preserved in buffered (sodium acetate) 5 per cent formalin. In the laboratory, samples were split with a Folsom splitter, and a quarter aliquot was examined. Eggs and larvae were removed and identified to species.

In some instances, apparent liberties have been taken in data contouring as contours changed where the biological data appear insufficient to warrant the change. This is because the biota were contoured as overlays on the temperature-salinity field. It should be obvious that pelagic biologic data must follow the same patterns as the physical data and hence, where biotic contours were subjective, the temperature or salinity field dictated the contour configuration (Austin, 1971).

RESULTS AND DISCUSSION

The data concerning oceanographic conditions and the ichthyoplankton collected are discussed separately.

OCEANOGRAPHIC CONDITIONS

Temperature and salinity values for September 9-10 showed surface-to-bottom vertical gradients ranging from 3° C. and 2 ppt inshore to 10° C. and 2 ppt offshore. By the sampling on November 17, the thermal stratification had been erased and a near isothermal water column had become established. A slight thermal inversion was present which is characteristic of New York coastal-estuarine waters in the fall (Hollman and Meguire, 1973).

A detailed analysis of the physical oceanographic conditions during the two sampling periods, as reported by Hollman and Meguire (1973), is summarized here. Winds for the week prior to the sampling in September were from the south and west quadrants which resulted in a net movement of surface waters to the north and east, transporting cooler (21°-22° C.) and lower salinity (<29.00 ppt) waters from New York Harbor out into the study area (Figure 2). This should have resulted in a balancing inflow by the near-bottom waters, which was in part true as shown by examination of the deeper density field.

Winds were from the north on November 17, but they switched to southwesterly during the period of the cruise on November 19. The distribution of the density field, when considered with the surface wind drift, suggests a bottom slope current to the north along the New Jersey coast and a southeasterly surface drift, the results of which were a tongue (Figure 3) of low salinity (<29.00 ppt) and cool (12° C.) water extending out from the harbor and overlaying more saline (>31.50 ppt) and warmer (>13° C.) water derived from the shelf (Figure 4).

ICHTHYOPLANKTON COLLECTED

Each species is discussed under the family to which it belongs.

CLUPEIDAE

Brevoortia tyrannus (menhaden)

Menhaden range along the western Atlantic coast from Nova Scotia to Florida. During early spring, adults move into the New York area where spawning begins in May and June. A second spawning period has been reported in the early fall (Wheatland, 1956; Coker, 1965; Austin, 1973).

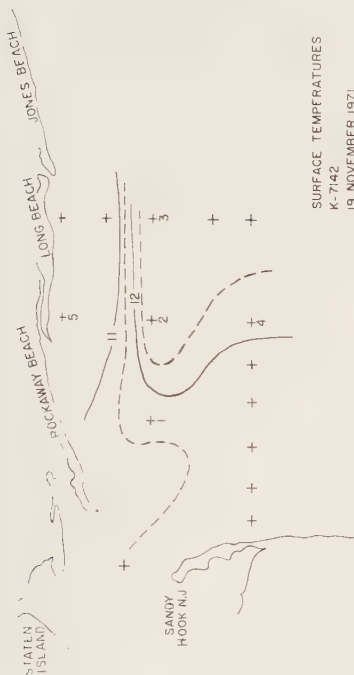
Eggs were collected in September indicating that menhaden were actively spawning in the New York Bight at that time. They were taken



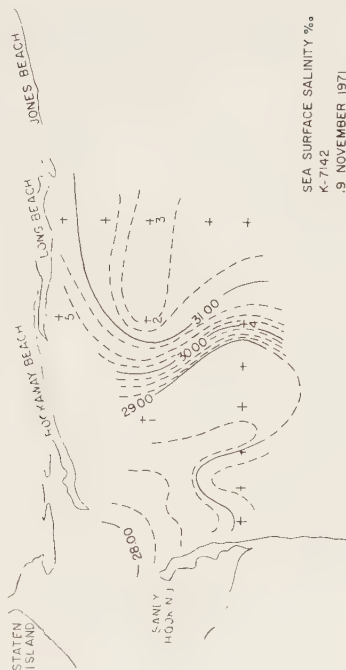
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9-10 SEPTEMBER 1971



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SURFACE TEMPERATURES
K-7142
19 NOVEMBER 1971



SEA SURFACE SALINITY ‰
K-7142
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Figure 3. Sea surface temperature (top) and salinity (bottom) on November 19, 1971.

Figure 2. Sea surface temperature (top) and salinity (bottom) on September 9-10, 1971.

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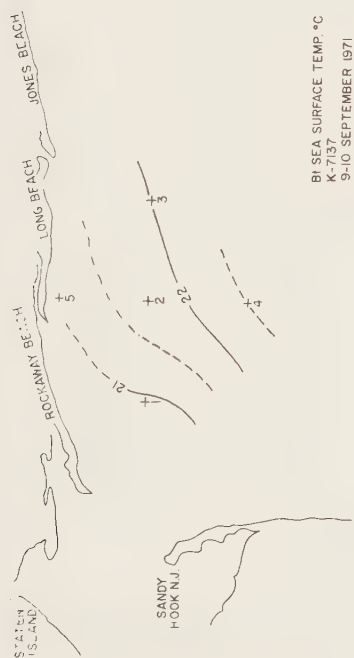
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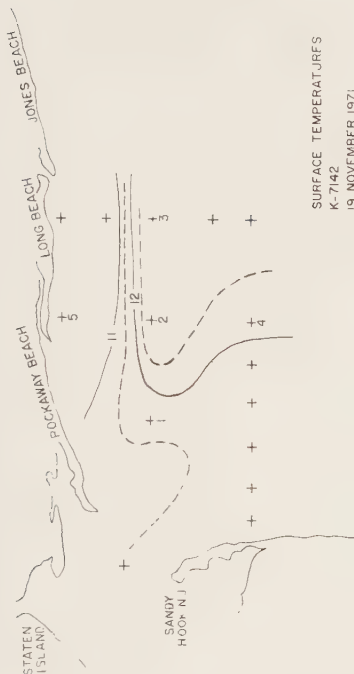
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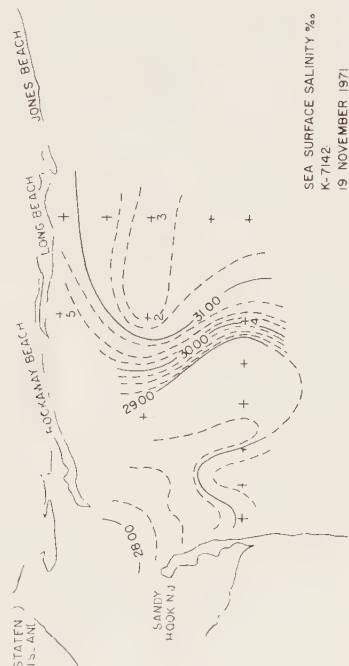
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Figure 3. Sea surface temperature (top) and salinity (bottom) on November 19, 1971.

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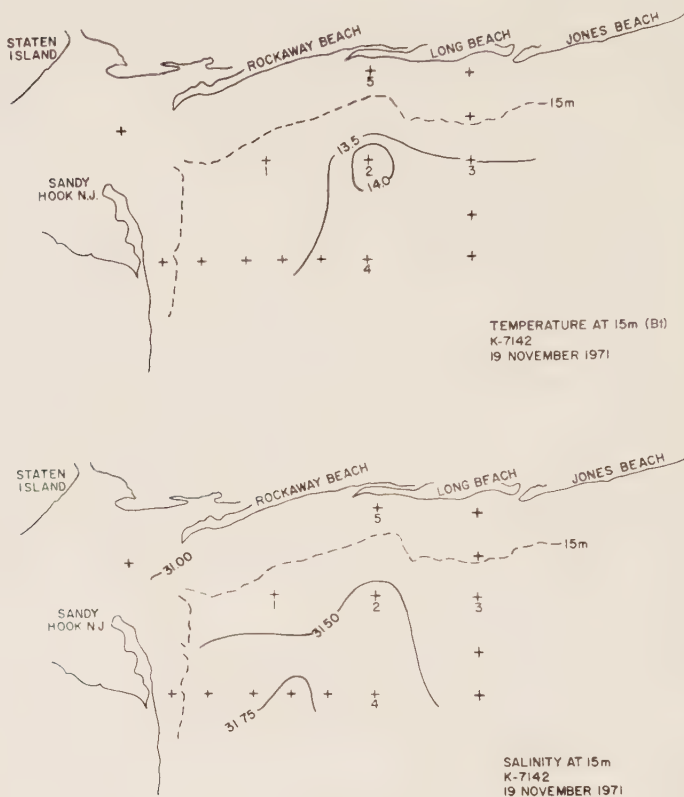


Figure 4. Temperature (top) and salinity (bottom) at a depth of 15 meters on November 19, 1971.

only from surface nets. Their distribution (Figure 5), when considered with the physical data (Figure 2), suggests that they may have come from New York Harbor or Sandy Hook Bay. Reintjes (1962) reported a hatching time of about 46 hours for *B. smithi* in salinities of 26-27 ppt and temperatures of 18°-19° C. which are very close to those measured during this study. At this rate, all eggs collected should have been spawned during the previous 48 hours. No eggs were collected in November.

Few larvae were taken during the September cruise (23/1000 m³) and then only from the surface at Station 1. In November, their distribution pattern (Figure 6), when examined in relation to the distribution of temperature and salinity (Figures 3 and 4), strongly suggests a southerly source. They were absent from waters derived from New York Harbor.

Anchoa mitchilli (bay anchovy)

The bay anchovy is a summer resident in the Bight and spawns in New York waters when temperatures exceed 17° C.

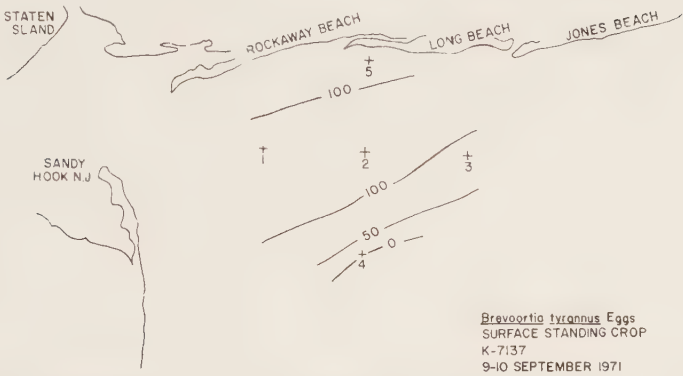


Figure 5. Distribution of menhaden eggs in the surface waters on September 9-10, 1971.

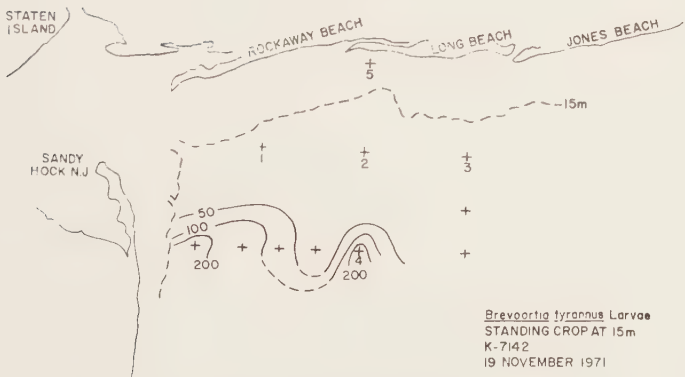
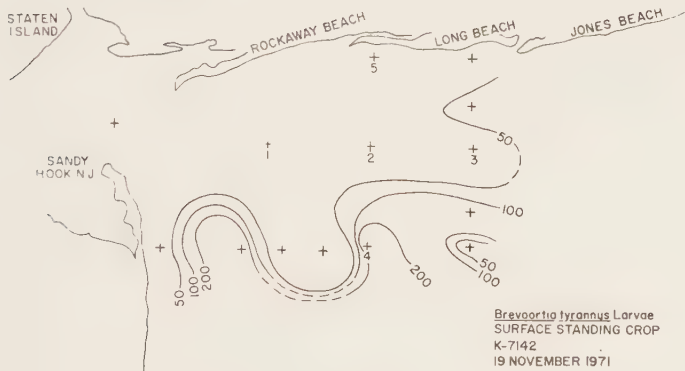


Figure 6. Distribution of menhaden larvae in the surface waters (top) and at a depth of 15 meters (bottom) on November 19, 1971.

Anchovy eggs were the second most abundant species collected in the surface waters of the Bight during the September cruise when temperatures were 20.9° to 22.5° C. Their surface distribution (Figure 7), like

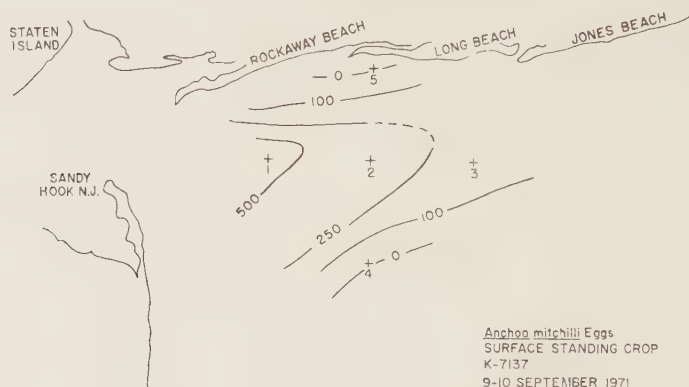


Figure 7. Distribution of anchovy eggs in the surface waters on September 9-10, 1971.

that of the menhaden, suggested a New York Harbor source. Anchovy eggs were taken only from surface waters during September and not at all during November. In another section of the study (Austin and Tollefson, 1973), 3,060 anchovies were collected by trawl at the rear shore station, nearly all of which appeared ripe.

Anchovy larvae were collected only once, in September, at a depth of 20 meters (16/1000 m³). This single collection could have been menhaden as positive identification was difficult due to their partially mascerated condition. No larvae were taken during November.

MERLUCCIIDAE

Merluccius bilinearis (silver hake)

Silver hake are an important constituent of the New York Bight sport fishery (Schaefer, 1960) from November through May.

Eggs were collected only during the September cruise from the surface at Station 2. The low standing crops (26/000 m³) suggest that spawning does not occur in any abundance in the New York Bight at this time of year. Colton and Marak (1970) reported the spawning season as summer but extending into October in the waters east of Long Island. Their occurrence in this study fell within the reported temperature range of 14°-21° C. although it is likely that spawning took place east of Long Island and that the eggs were carried into the Bight.

The larvae were taken only in November (temperature, 12.11°-13.20° C.; salinity, 30.96-31.42 ppt) at Stations 3 and 4 in the surface waters. Their abundance (46-57/1000 m³) was low compared with that of other species, and, as noted with respect to eggs, spawning probably does not occur in the region of the Bight during the fall.

Urophycis chuss (squirrel or red hake)

The red hake is reported to spawn east of Long Island from May through August (Colton and Marak, 1970) and in Block Island Sound from June through November in temperatures ranging from 11° to 19° C. (Merriman and Sclar, 1952).

Eggs were collected only during September (29-105/1000 m³) and were more abundant in the surface nets than in the deeper tows. None were collected during November, and none were reported from adjacent Sandy Hook Bay by Coker (1965).

Larvae were taken during both September (15-116/1000 m³) and November (15-32/1000 m³) and were more abundant in the surface tows. Their surface distribution during November coincided with the boundary of the tongue of "fresher" (salinity, <29.00 ppt) waters derived from New York Harbor, but it is difficult to reconcile that they came from the harbor proper. More likely they were transported into the area, possibly from the south during the previous days' southwesterly winds. In addition, these southwesterly winds could have produced localized coastal upwelling bringing southerly, deeper waters to the surface at the harbor entrance along the Sandy Hook shore.

SCIAENIDAE

Cynoscion regalis (weakfish)

The weakfish is a prolific inshore and embayment spawner (Perlmutter, 1939; Richards, 1959; Herman, 1963), at times exhibiting a bimodal spawning season in New York waters (Austin, 1973; Austin et al., 1973) which suggests the presence of two separate spawning stocks (Welsh and Breder, 1924 *vide* Perlmutter, 1939). It was essentially absent from commercial landings in New York from 1948 to 1968 (McHugh, 1973), which Perlmutter et al. (1956) suggested was due to the failure of several southern-stock year classes. This is reflected in data for Sandy Hook as reported by Coker (1965) who did not record any weakfish ichthyoplankters in 1960-1961.

Weakfish eggs were the most abundant species taken at all five surface stations during the September cruise (average standing crop at all stations 106/1000 m³), and they ranked second in abundance in the deeper tows (average 30/1000 m³). Their surface distribution (Figure 8) sug-

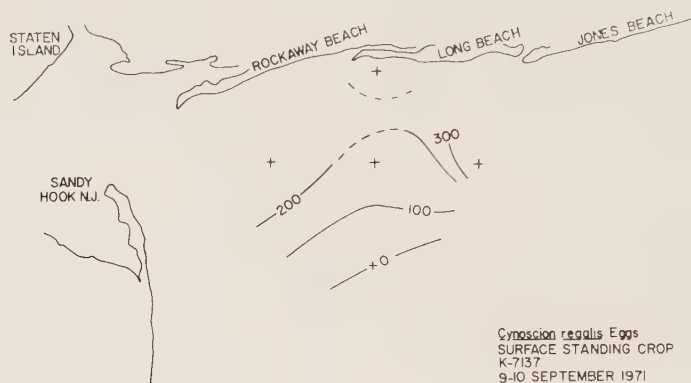


Figure 8. Distribution of weakfish eggs in the surface waters on September 9-10, 1971.

suggested in inshore source, either the inlets along Long Island's south shore, New York Harbor or the inlets along the New Jersey coast. None were taken during November.

Larvae were collected only once, in September in a surface tow at Station 4 (29/1000 m³). None were taken in November.

LABRIDAE

Tautoga onitis (tautog or blackfish)

The tautog is a prolific spawner throughout its known range. In New York waters it exhibits a protracted season ranging from early May through early September (Perlmutter, 1939; Wheatland, 1956; Austin et al., 1973). Despite the protracted nature of the spawning season (based upon larval abundance), the effective spawn may be limited to a narrower, early-summer range as few larvae are found after temperatures surpass 21.0° C. (Austin, 1973).

Very few eggs were taken during the September cruise (23-34/1000 m³) and only from the surface waters at the two stations closest to shore. None were collected during November.

No larvae were taken during the course of the study.

Tautogolabrus adspersus (cunner or bergall)

Cunner, like the tautog, spawn throughout the summer after temperatures reach 12°-14° C. Egg-to-larva ratios are similar to those for the tautog, as few larvae are collected after summer temperatures surpass 21° C. Coker (1965) did not report any cunner eggs or larvae from adjacent Sandy Hook Bay, which is difficult to reconcile because it is such a ubiquitous coastal fish.

Eggs were taken only from the surface waters at Station 1 during September (46/1000 m³).

No larvae were ever taken, probably because it was too late in the year. Studies in the vicinity of Davids Island by the National Marine Fisheries Service (1972b) yielded larvae between mid-June and late August.

STROMATEIDAE

Peprilus triacanthus (butterfish)

Butterfish spawn during the late summer east of Long Island (Merriman and Sclar, 1952; Austin, 1973). The eggs are generally reported as most abundant in the surface waters.

Butterfish eggs were the third most abundant species over-all and the most abundant in the deeper tows. They were collected at all stations during the September cruise, but, unlike those reported in previous studies (e.g., Merriman and Sclar, 1952), they were more abundant in the deeper, cooler and more saline bottom waters. In their study of the ichthyoplankton of Block Island Sound, Merriman and Sclar (1952) suggested that spawning occurs offshore in the Atlantic and that the eggs are carried into the Sound. The distribution of eggs in the tows from below the thermocline (Figure 9) suggests an offshore source. This is further supported by the estuarine circulation patterns measured during this study (Hollman and Meguire, 1973).

Butterfish larvae were the fourth most abundant species in the study area during September and the most abundant in the deeper tows. However, the larvae showed no apparent spatial distribution pattern. In November, larvae were collected at those stations (C-5, C-7) showing bio-

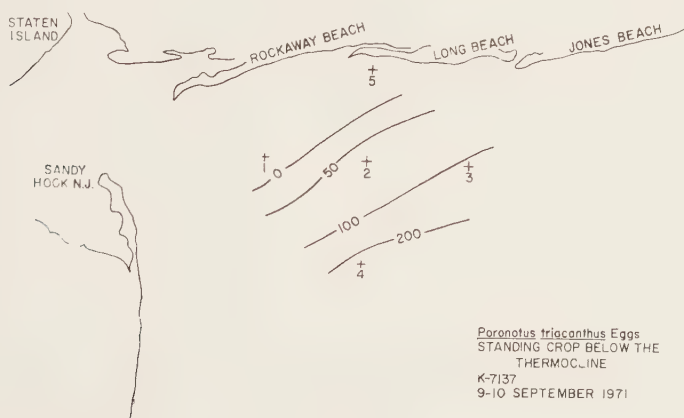


Figure 9. Distribution of butterfish eggs below the thermocline on September 9-10, 1971. Since this figure was drafted, *Paronotus* as the generic name of the butterfish has been superseded by *Peprilus* as given in the text.

logical characteristics of the waters farther offshore (Austin and Tollefson, 1973).

SCORPAENIDAE

Sebastes marinus (redfish or ocean perch)

Redfish or ocean perch range from western Greenland to New England and tend to occur farther offshore along the southern extent of their range. Redfish spawn in early summer when temperatures range from 5° to 10° C.

No eggs were taken.

A single larva was collected (20 millimeters long) in a 16-foot head-rope otter trawl (Austin and Tollefson, 1973). Undoubtedly, this specimen represented an earlier seasonal spawning to the north. Bigelow and Schroeder (1953) reported that development is very gradual and that the larvae drift in the surface waters until they are 20 millimeters long. This single specimen probably has drifted into the Bight from the North.

TRIGLIDAE

Prionotus carolinus (northern searobin)

The searobin is one of the most abundant fish in inshore New York waters in summer, moving offshore during the fall. Spawning occurs in the near-shore waters, from June to September around Long Island according to Perlmutter (1939), Wheatland (1956) and Austin et al. (1973).

Eggs were collected at three stations during September, but at none during November. September concentrations ranged from 52 to 93/1000 m³. All were collected from the surface only, although Williams (1968) found them evenly distributed throughout the water column in Long Island Sound.

Few larvae were collected (23-34/1000 m³) during September from the surface, and none were taken during November. Although Coker (1965) found searobin eggs to be the most abundant species in adjacent Sandy Hook Bay during May-June, he did not find any larvae.

BOTHIDAE

Scophthalmus aquosus (windowpane flounder)

The windowpane spawns in Long Island Sound in the spring during late May to early June (temperature, 10°-15° C.) and again during September or October depending on the temperature.

Eggs were collected only during September and only at Station 1 (23/1000 m³). From their distribution and abundance, it would appear that the sampling missed the peak spawning period.

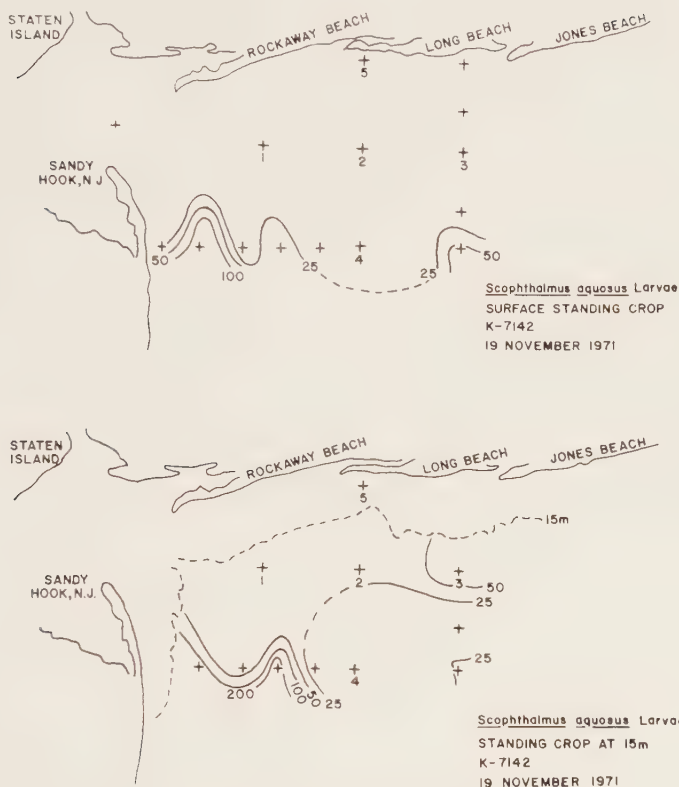


Figure 10. Distribution of windowpane flounder larvae at the surface (top) and at a depth of 15 meters (bottom) on November 19, 1971.

Larvae were collected only during the November cruise. They were most abundant in the deeper waters along the southern transect. Their distribution at a depth of 15 meters (Figure 10) was suggestive of a southern source. Most of the deeper larvae were larger than those collected at the surface and many appeared near metamorphosis.

Paralichthys dentatus (fluke or southern flounder)

The fluke spawns offshore in the fall from south of Long Island to southeast of Cape May (N.J.)

Although none were taken in September, eggs were collected in November in the surface waters at the southern and offshore stations. The low numbers (29-74/1000 m³) did not indicate that spawning occurs in the immediate area of the Bight.

Larvae were collected only during November. Their surface distribution (Figure 11), when examined with the surface temperature and sa-

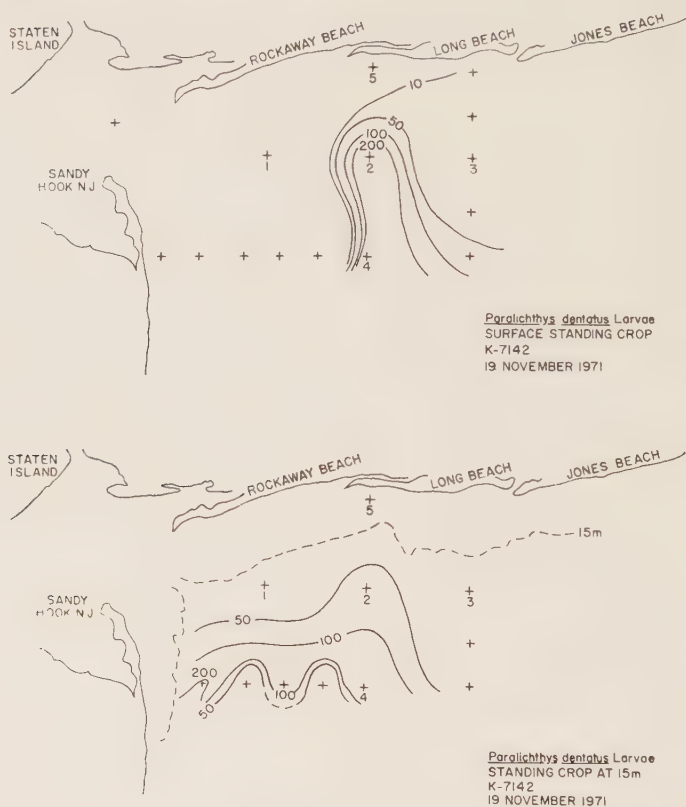


Figure 11. Distribution of fluke larvae at the surface (top) and at a depth of 15 meters (bottom) on November 19, 1971.

linity fields, indicates that they had been transported into the area from the south. At a depth of 15 meters, their abundance and distribution, considered in light of the salinity distribution (Figure 4), suggest, as did those of the menhaden, a southerly source, probably farther offshore.

GENERAL RELATIONSHIPS

Spawning in New York waters by finfish occurs in three modes, a cold water-early spring spawning, a late spring-early summer spawning and an early fall spawning. Most studies conducted in these waters have concentrated on the late spring-early summer period which is when most species spawn. Consequently, little is known about the autumnal ichthyoplankton. Spawning products in the New York Bight are derived from three sources: resident (e.g., tautog and windowpane flounder); migratory (e.g., menhaden and weakfish); and offshore (e.g., fluke) stocks. Resident and migratory stocks spawn in the New York Bight, whereas

the offshore stocks spawn outside the Bight and the products are transported in.

The bulk of the spawning that occurs in coastal New York waters is by migratory stocks (Perlmutter, 1939; Coker, 1965; Austin, 1973). Principal among these in the New York Bight are the menhaden, anchovy, weakfish, mackerel and searobin. Of these, the menhaden and weakfish exhibit a bimodal spawning peak, the first phase being in late spring and the second in early fall. It has been suggested that this pattern is due to the presence of more than one stock (Welsh and Breder, 1924 *vide* Perlmutter, 1939). It is this bimodal pattern that accounts, in large part, for the fall spawning season in coastal New York waters. The only resident species to spawn in the fall is the windowpane flounder, and this, too, is a secondary peak compared with the spring spawning. The fluke, also a dominant fall larval species, spawns only at this time but not in the region of the Bight. It spawns farther offshore, and the larvae are transported into the Bight by the currents. The New York Bight, unlike Long Island Sound, has direct access to the open continental shelf of the Atlantic Bight. The bottom waters, of offshore origin, and the surface waters, under the influence of local wind systems, provide a mechanism whereby the eggs and larvae of estuarine spawners mix with those of offshore fish.

CONCLUSIONS

During late summer, while the water column is thermally stratified, the ichthyoplankton in the surface waters of the apex of the New York Bight are principally derived from local estuarine sources. During the early fall, following the autumnal overturn of the water column, the principal source of ichthyoplankton is the New Jersey coastal waters to the south and the continental shelf to the southeast. Principal fall spawners in the Bight are: the migratory menhaden, anchovy and weakfish; the resident windowpane flounder; and the offshore-spawning butterfish and fluke. Circulation patterns in the Bight provide a mechanism for the shoreward transport of ichthyoplankton in the near-bottom waters and a wind-dependent, directionally variable transport in the surface waters.

LITERATURE CITED

- AUSTIN, H. 1971. The characteristics and relationships between the calculated geostrophic current component and selected indicator organisms in the Gulf of Mexico Loop Current System. Ph.D. thesis, Dept. Oceanog., Fla. State Univ.
- . 1973. The ecology of Lake Montauk: planktonic fish eggs and larvae. New York Ocean Sci. Lab., Tech. Rept. 21.
- AUSTIN, H., J. DICKINSON and C. HICKEY. 1973. An ecological study of the ichthyofauna at the Northport Power Station, Long Island, New York. Final report submitted to the Long Island Lighting Co. by the New York Ocean Sci. Lab.

- AUSTIN, H., and D. TOLLEFSON. 1973. A survey of the ichthyofauna of the New York Bight with emphasis on the distribution of pelagic eggs and larvae, September and November, 1971. In: Oceanography of the New York Bight: Physical, Chemical, Biological. New York Ocean Sci. Lab., Tech. Rept. 17(2):146-188.
- BIGELOW, H., and W. SCHROEDER. 1953. Fishes of the Gulf of Maine. U.S. Fish and Wildl. Serv., Fish Bull. 74:173-182.
- BREder, C. 1938. The species of fish in New York Harbor. Bull. N.Y. Zool. Soc. 41(1):23-29.
- COLTON, J., and R. MARAK. 1970. Guide for identifying the common planktonic fish eggs and larvae of continental shelf waters, Cape Sable to Block Island. U.S. Bur. Comm. Fish., Biol. Lab., Woods Hole (Mass.), Lab. Ref. No. 69-09.
- COKER, R. 1965. Planktonic fish eggs and larvae of Sandy Hook Estuary. Chesapeake Sci. 6(2):92-95.
- HERMAN, S. 1963. Planktonic fish eggs and larvae of Narragansett Bay. Limnol. and Oceanog. 8(1):103-109.
- HOLLMAN, R., and R. MEGUIRE. 1973. The physical oceanography of the New York Bight, September-November, 1971. In: The Oceanography of the New York Bight: Physical, Chemical, Biological. New York Ocean Sci. Lab., Tech. Rept. 17(1):3-34.
- McHUGH, J. 1973. Marine fisheries of New York State. National Mar. Fish. Serv., Fish. Bull. 70(3):585-610.
- MERRIMAN, D., and R. SCLAR. 1952. The pelagic fish eggs and larvae of Block Island Sound. Bull. Bingham Oceanog. Coll. 13(3):165-219.
- NATIONAL MARINE FISHERIES SERVICE. 1972a. The effects of waste disposal in the New York Bight, Section 4, finfish studies. Final report submitted to the Coastal Eng. Res. Center, U.S. Army Corps Eng., Washington, D.C.
- . 1972b. Davids Island Phase I: a short term ecological survey of western Long Island Sound. Informal Rept. No. 7 submitted to Battelle Northwest.
- NISKIN, S. B., and J. I. JONES. 1963. New collecting and recording devices for limnological and oceanographic research. Proc. 6th Conf. Great Lakes Res., Univ. Mich., Great Lakes Res., Div. Inst. Sci. and Tech.
- PERLMUTTER, A. 1939. An ecological survey of young fish and eggs identified from tow-net collections. In: A Biological Survey of the Salt Waters of Long Island, Part II. N.Y.S. Cons. Dept.:11-71.
- PERLMUTTER, A., B. MILLER and J. POOLE. 1956. The weakfish (*Cynoscion regalis*) in New York waters. N.Y. Fish and Game Jour. 3(1):1-43.
- PERLMUTTER, W., E. SCHMIDT and E. LEFF. 1967. Distribution and abundance of fish along the shores of the lower Hudson River during the summer of 1965. N.Y. Fish and Game Jour. 14(1):47-75.
- REINTJES, J. 1962. Development of eggs and yolk-sac larvae of yellowfin menhaden. U.S. Bur. Comm. Fish., Fish. Bull. 202(62):93-102.
- RICHARDS, S. 1959. Pelagic fish eggs and larvae in Long Island Sound. In: Oceanography of Long Island Sound. Bull. Bingham Oceanog. Coll. 17(1):95-124.
- SCHAEFER, R. 1960. Growth and feeding habits of the whiting or silver hake in the New York Bight. N.Y. Fish and Game Jour. 7(2):85-98.
- WELSH, W., and C. BREder. 1924. A contribution to the life histories of Scaenidae of the U.S. Coast. Bull. U.S. Bur. Fish. 34(1923-1924):141-201.
- WHEATLAND, S. 1956. Pelagic fish eggs and larvae. In: Oceanography of Long Island Sound, 1952-1954, Part VII. Bull. Bingham Oceanog. Coll. 15:234-314.
- WILLIAMS, G. C. 1968. Bathymetric distribution of planktonic fish eggs in Long Island Sound. Limnol. and Oceanog. 13(2):382-385.

CHANGE IN ABUNDANCE OF INSHORE FISHES IN ONEIDA LAKE, 1916 TO 1970¹

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ABSTRACT

The frequency of occurrence of 57 species of fish captured by seining in the littoral zone in Oneida Lake in 1916-1927 was compared with similar data for 1960-1970. The incidence of eight species—chain pickerel, silvery minnow, spot-tail shiner, bridle shiner, bigmouth shiner, yellow bullhead, trout-perch and Iowa darter—decreased significantly, probably due to shoreline development and subtle eutrophication. The incidence of the bluegill and white perch increased, with the latter being the only exotic species to become well established between 1916 and 1970. The populations of large percids and centrarchids—the important recreational species—apparently did not change significantly.

Oneida Lake is large (51,000 acres), shallow (mean depth 25 feet) and productive. Consequently, it is inhabited by numerous species of fish, many of which should be well suited to environmental conditions at any particular time. Early in this century (1916-1927), the life histories of the fishes were studied to aid in the formulation of a "system of fish cultural management" for Oneida Lake (Adams and Hankinson, 1928). Adams and Hankinson made extensive collections and kept detailed records of their findings. More recently (since 1955), fluctuation in angling success has led to intensive study of the populations of dominant game fishes, i.e., the walleye, yellow perch and smallmouth bass. During the latter period, the relative abundance of most species was measured. The purpose of the present paper is to note changes between 1916-1927 and 1960-1970 in the species composition and abundance and to discuss the significance of these changes in relation to environmental conditions.

METHODS

Under "distribution records", Adams and Hankinson (1928) listed the number of times that a species was captured, together with the survey number of the original collection but not always the method of capture. Therefore, the original collection cards at Syracuse University were examined in detail. Although the method of capture was not specifically stated on all cards either, the species of fish taken, the depth of water and the type of habitat usually made this obvious. As nearly as could be

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determined, Adams and Hankinson made 104 fish collections with seines during the summers of 1916 and 1917, the spring of 1921 and September of 1927. Seines 4 feet deep and 4, 15 or 25 feet long were used. Size of mesh is not known. The relative seining effort expended in making an individual collection was highly variable. Some collections consisted of one haul of a larger seine, while others represented multiple hauls with several types of seines over distances of up to $\frac{1}{2}$ mile of shoreline.

During the period of 1960 to 1970, 13 locations around Oneida Lake were seined from June through August. Several sites were usually sampled at each location. Seine hauls (520 in all) were made by laying out a 75-foot bag seine with $\frac{1}{4}$ -inch woven mesh at a distance of 50 to 100 feet from shore and parallel to it. Each haul was started at a depth of 3 to 4 feet depending on the site. The seine was pulled directly to shore, and the fish were counted and released. Most of the fish caught by seine were smaller species and young of the year of larger species.

The frequency of occurrence or probability of capture (p) of each species in the total seine hauls (n) for all years during each of the two periods was determined, and 95 per cent confidence limits were computed using the normal approximation of the binomial distribution (Steele and Torrie, 1960) which is

$$p \pm 1.96 \sqrt{\frac{p(1-p)}{n}}$$

An additional 15 seine hauls were made from May to July in 1974 at selected sites to verify the disappearance of certain species from areas where they had previously been abundant. Data on fish captured by other gear were combined with those for the seine catches to compile a check list for each period. Common and scientific names follow Bailey (1970).

RESULTS AND DISCUSSION

Differences in gear and seining methods invalidated direct application of catch per unit of effort as a measure of relative species abundance in 1916-1927 and 1960-1970, for reasons discussed by Paloumpis (1958). Use of an enumeration datum, i.e., the occurrence or absence of a species, should minimize the error, although the bias is not eliminated for rare species for which the total amount of effort needed to capture a single specimen is critical. Nevertheless, general conclusions can be derived from the data. It was assumed that the seining effort in each collection in 1916-1927 was comparable to a haul in 1960-1970 with respect to the probability of sampling a niche of the rarer species of fish. In this regard, the use of more efficient seines in the latter period would have been offset somewhat by the sampling of more diverse habitats by Adams and Hankinson (1928).

Confidence intervals around frequency of occurrence did not overlap for 19 of the 57 species taken by seining in either or both of the periods (Figure 1). The abundance of nine species—carp, emerald shiner, white sucker, burbot, white perch, bluegill, yellow perch, logperch and walleye—appeared to have increased, while there appeared to have been substantial declines in the abundance of 10 species—chain pickerel, silvery minnow, bridle shiner, bigmouth shiner, spottail shiner, fallfish, yellow bullhead, trout-perch, brook stickleback and Iowa darter.

The higher frequency of occurrence for percids, the emerald shiner and carp are all suspect, however. Since sampling for young yellow perch and walleyes was a primary consideration in the selection of a seining site in 1960-1970, the abundance of these two species and the closely associated logperch was probably overestimated relative to that in 1916-1927 (99 vs. 55 per cent, 78 vs. 12 per cent and 66 vs. 39 per cent, respectively). All three species were considered to be very common by Adams and Hankinson (1928). The apparent increase in abundance of the emerald shiner from 1916-1927 (14 per cent) to 1960-1970 (38 per cent) is invalid, since morphologically similar rosyface shiners (15 per cent frequency in 1916-1927) were not distinguished from emerald shiners by the seining crews in the later period. Adams and Hankinson found carp so abundant in Oneida Lake that the species was the object of a control program (Smallwood and Struthers, 1928). The apparent difference in occurrence of carp between the two periods (0 vs. 5.4 per cent) was probably due to the ineffectiveness of the smaller seines used by Adams and Hankinson for capturing this unusually wary fish; the avoidance of such nets by carp was discussed by Hunter and Wisby (1964). The reasons for the failure of Adams and Hankinson to seine more burbot (0 vs. 3.3 per cent) and white suckers (24 vs. 66 per cent), which they found to be abundant by other means, are more obscure.

The fallfish and brook stickleback are fish of streams and backwater areas (Adams and Hankinson, 1928). The greater frequency of occurrence of the two species recorded in 1916-1927 (14 vs. 1.0 per cent and 4.9 vs. 0.1 per cent, respectively) was likely due in part to the tendency of Adams and Hankinson to seine off the mouths of inlet streams, although it appears that the abundance of fallfish has declined somewhat in the open lake.

Other changes in abundance are real. No bluegills were seined by Adams and Hankinson, and its presence was based on a single market specimen. The capture of bluegills in 3.7 per cent of the seine hauls in 1960-1970 reflects a significant increase for this shallow-water species which is easily captured by seining. The white perch, which was taken in 21 per cent of the hauls in 1960-1970, invaded Oneida Lake about 1952 (Dence and Jackson, 1959) and is now common.

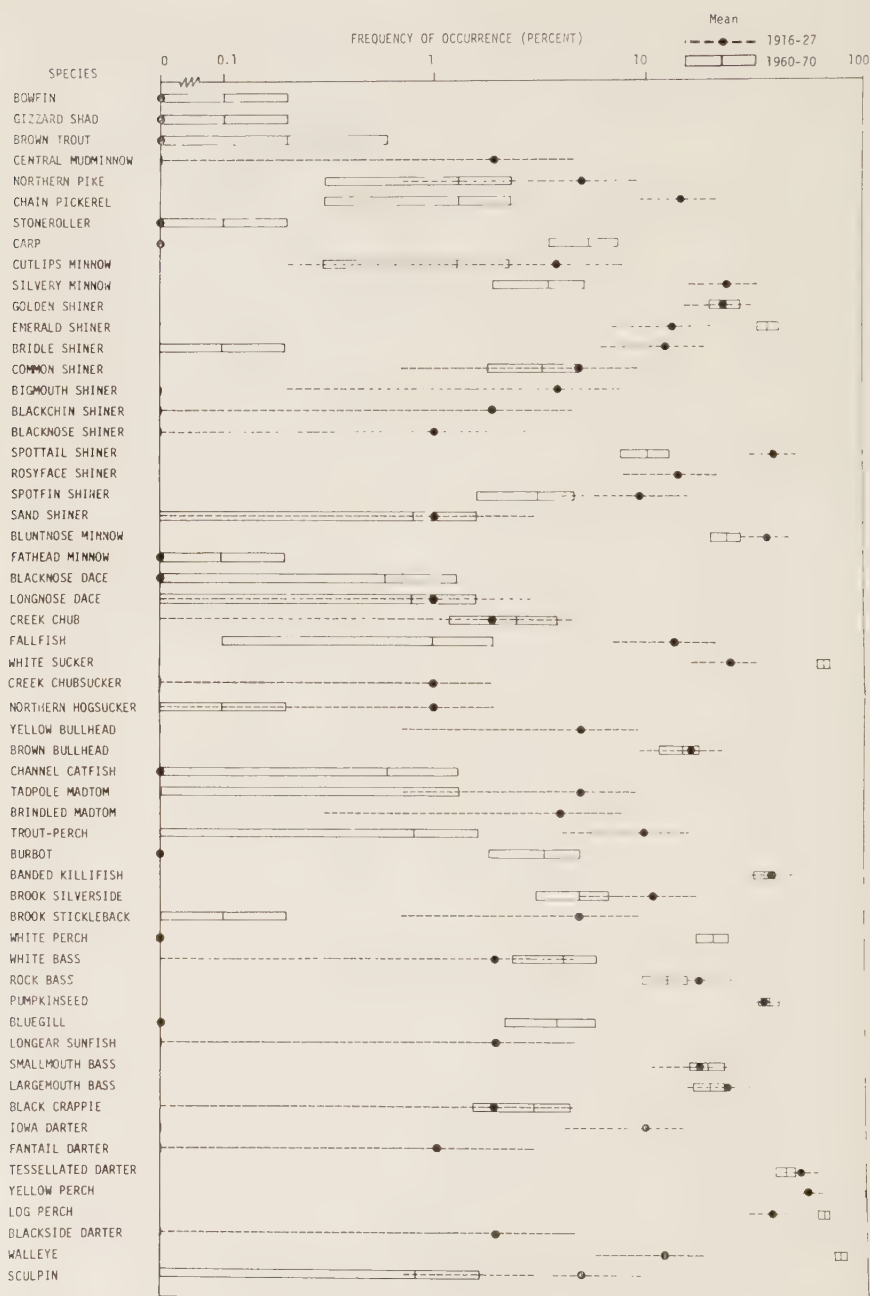


Figure 1. Frequency of occurrence (mean percentage with 95 per cent confidence limits) of fishes taken by seining in Oneida Lake, 1916-1927 and 1960-1970.

Decreases in frequency of occurrence of the once abundant and easily seined silvery minnow (24 to 3.5 per cent) and spottail shiner (40 to 10 per cent) are highly significant. Four species that were relatively uncommon in 1916-1927—bridle shiner (13 per cent), bigmouth shiner (3.9 per cent), yellow bullhead (4.9 per cent) and Iowa darter (9.7 per cent)—have become extinct or nearly so in Oneida Lake; no confirmed specimens were taken by any method from 1955 to 1974. Since the silvery minnow, spottail shiner and Iowa darter are very intolerant of siltation and organic enrichment (Trautman, 1957), their decline could indicate subtle deterioration of environmental quality. Trautman stated that the yellow bullhead also is intolerant of adverse conditions such as increased turbidity, especially when the brown bullhead is present. On the other hand, populations of other small fishes sensitive to turbidity and organic pollution, such as the emerald shiner and brook silverside (Trautman, 1957), have apparently not changed greatly.

Another species which could be approaching the threshold of extinction in the lake is the chain pickerel, which was taken in 13 per cent of the seine hauls in 1916-1927 and stated by Adams and Hankinson (1928) to be one of the most important game fish there at that time. Decreasing abundance of this fish (taken in only 0.6 per cent of the hauls in 1960-1970) is undoubtedly related to destruction of the once abundant shallow, weed-choked marshes bordering Oneida Lake which according to Adams and Hankinson were used as spawning grounds by chain pickerel and northern pike. Some of these marshes have been drained for agriculture, while others have been filled to accommodate a nine-fold increase in the number of dwellings between 1900 and 1960 (Greeson, 1971). Frequency of occurrence of northern pike also declined (4.9 to 1.3 per cent), but the decrease was less pronounced than that of the pickerel.

Trout-perch in Oneida Lake are abundant in water less than 5 feet deep only during the spawning season in late spring and early summer (Adams and Hankinson, 1928). Therefore, their abundance was not measured precisely by seining in 1960-1970 which usually began near the end of June. Nevertheless, the apparent decline of the species between 1916-1927 and 1960-1970 (9.7 to 0.8 per cent) coincided with and was followed by a significant downward trend between 1959 and 1974 in trawl catches for both age 0+ ($r = -0.78$) and I+ ($r = -0.67$) fish (unpublished data). Probably severe oxygen depletions in deep water in recent years (Jacobsen, 1966) are responsible for limiting the distribution of this species.

All the species recorded from Oneida Lake, whether taken by seining or by other gear, are listed in Table 1 for the periods 1916-1927 as given by Adams and Hankinson (1928) and 1960-1970 as noted during the

TABLE 1. CHECK LIST OF THE FISHES OF ONEIDA LAKE, 1916-1927 AND 1960-1970

Common name	Scientific name according to Bailey (1970)	Occurrence*		Scientific name used by Adams and Hankinson (1928)
		1960-1970	1916-1927	
Sea lamprey§	<i>Petromyzon marinus</i>	+	+	<i>P. marinus</i>
Lake sturgeon§	<i>Acipenser fulvescens</i>	+	-	<i>A. fulvescens</i>
Longnose gar§	<i>Lepisosteus osseus</i>	+	-	<i>L. osseus</i>
Bowfin	<i>Amia calva</i>	+	+	<i>A. calva</i>
Alewife§	<i>Anguilla rostrata</i>	+	+	<i>A. rostrata</i>
American eel§	<i>Alosa pseudoharengus</i>	+	+	<i>Pomolobus pseudo-harengus</i>
Gizzard shad	<i>Dorosoma cepedianum</i>	+	+	..
Cisco§	<i>Coregonus artedii</i>	+	-	<i>Leucichthys artedi tullibee</i>
Rainbow trout§	<i>Salmo gairdneri</i>	+	-	<i>S. irideus</i>
Brown trout	<i>Salmo trutta</i>	+	-	<i>S. fario</i>
Brook trout§	<i>Salvelinus fontinalis</i>	+	+	<i>S. fontinalis</i>
Central mudminnow	<i>Umbra limi</i>	+	+	<i>U. limi</i>
Northern pike	<i>Esox lucius</i>	+	+	<i>E. lucius</i>
Chain pickerel	<i>Esox niger</i>	+	+	<i>E. niger</i>
Stoneroller	<i>Campostoma anomalum</i>	+	-	..
Carp	<i>Cyprinus carpio</i>	+	+	<i>C. carpio</i>
Cutlips minnow	<i>Exoglossum maxillingua</i>	+	+	<i>E. maxillingua</i>
Silvery minnow	<i>Hybognathus nuchalis</i>	+	+	<i>H. regius</i>
Golden shiner	<i>Notemigonus crysoleucas</i>	+	+	<i>N. crysoleucas</i>
Emerald shiner	<i>Notropis atherinoides</i>	+	+	<i>N. atherinoides</i>
Bridle shiner	<i>Notropis bifrenatus</i>	-	+	<i>N. biprenatus</i>
Common shiner	<i>Notropis cornutus</i>	+	+	<i>N. cornutus</i>
Bigmouth shiner	<i>Notropis dorsalis</i>	+	+	<i>N. dorsalis</i>
Blackchin shiner	<i>Notropis heterodon</i>	+	+	<i>N. heterodon</i>
Blacknose shiner	<i>Notropis heterolepis</i>	+	+	<i>N. heterolepis</i>
Spottail shiner	<i>Notropis hudsonius</i>	+	+	<i>N. hudsonius</i>
Rosyface shiner	<i>Notropis rubellus</i>	+	+	<i>N. rubifrons</i>
Spotfin shiner	<i>Notropis spilopterus</i>	+	+	<i>N. whiffli</i>
Sand shiner	<i>Notropis stramineus</i>	+	+	<i>N. deliciosus</i>
Bluntnose minnow	<i>Pimephales notatus</i>	+	+	<i>Hyborthynchus notatus</i>
Fathead minnow	<i>Pimephales promelas</i>	+	+	..
Blacknose dace	<i>Rhinichthys atratulus</i>	+	+	<i>R. atronasus</i>
Longnose dace	<i>Rhinichthys cataractae</i>	+	+	<i>R. cataractae</i>
Creek chub	<i>Semotilus atromaculatus</i>	+	+	<i>S. atromaculatus</i>

[illegible]

* Recorded (+); not recorded (-).

§ Not taken by seining.

present study. Differences between the two periods must be interpreted with caution because most omissions involve fishes that were rare and likely could have been present without being detected during either period. Of the 57 species recorded by Adams and Hankinson, seven—bridle shiner, bigmouth shiner, blackchin shiner, yellow bullhead, longear sunfish, Iowa darter and fantail darter—were relatively uncommon then and were not taken during the later period. On the other hand, 14 species not found earlier were identified during 1960-1970—lake sturgeon, longnose gar, gizzard shad, rainbow trout, brown trout, brook trout, stoneroller, fathead minnow, longnose sucker, stonecat, white perch, white crappie, freshwater drum and slimy sculpin. Adams and Hankinson guessed that the sturgeon, gar, trouts, drum and sculpin were present in small numbers in the lake during the earlier period. Of the other seven species, only the exotic gizzard shad and white perch were identified more than several times and would represent a significant addition to the fish community. Dence and Jackson (1959) discussed the timing and means of invasion of Oneida Lake by these and other species. It is likely that the fathead minnow has been introduced from anglers' bait buckets.

Considering the great potential for faunistic change in Oneida Lake (large size and location on the New York State Barge Canal System), the fish community has been altered little during the interval between the two studies discussed here. The yellow perch was the most abundant species in 1916-1927 and remained so in 1970. The incidence of capture for many species such as common centrarchids (i.e., rock bass, pumpkinseed, smallmouth bass and largemouth bass) were virtually unchanged. The white perch is the only exotic to have become well established. This addition together with declines in abundance of the American eel (Dence and Jackson, 1959) and chain pickerel due to artificial alterations in the environment (dams and shoreline development) are the only dramatic changes among the larger fishes of the lake, although burbot and white suckers may have become more numerous inshore. In general, the stability supports the findings of Greeson (1971) that the nutrient input from cultural sources is low, that the gross chemical composition of Oneida Lake has remained stable and that the lake's eutrophic character is attributable to edaphic and morphological features. With the exception of a few small cyprinids, the subtle environmental changes which have led to marked changes in bottom fauna (Clady, 1975; Harman and Forney, 1970; Jacobsen, 1966) apparently have had less dramatic effects on the more mobile fishes.

LITERATURE CITED

- ADAMS, C. C., and T. L. HANKINSON. 1928. The ecology and economics of Oneida Lake fish. *Roosevelt Wildl. Ann.* 1:235-548.
- BAILEY, R. M. (ed.) 1970. A list of common and scientific names of fishes from the United States and Canada (3rd ed.). *Am. Fish Soc., Spec. Publ.* No. 6

- CLADY, M. D. 1975. Comparison of the bottom fauna in 1916 and 1967 in a bay of Oneida Lake, New York. N.Y. Fish and Game Jour. 22(2):114-121.
- DENCE, W. A., and D. F. JACKSON. 1959. Changing chemical and biological conditions in Oneida Lake, New York. School Sci. and Math. 1959:317-325.
- GREESON, P. E. 1971. Limnology of Oneida Lake with emphasis on factors contributing to algal blooms. U.S. Dept. Int., Geol. Surv., Open File Report. (Published by N.Y.S. Dept. Environ. Cons.)
- HARMAN, W. N., and J. L. FORNEY. 1970. Fifty years of change in the molluscan fauna of Oneida Lake, New York. Limnol. and Oceanog. 15:454-460.
- HUNTER, J. R., and W. J. WISBY. 1964. Net avoidance behavior of carp and other species of fish. Jour. Fish. Res. Bd. Canada 21:613-633.
- JACOBSEN, T. V. 1966. Trends in abundance of the mayfly (*Hexagenia limbata*) and chironomids in Oneida Lake. N.Y. Fish and Game Jour. 13(2):168-175.
- PALOUMPIS, A. A. 1958. Measurement of some factors affecting the catch in a minnow seine. Proc. Iowa Acad. Sci. 65:580-586.
- SMALLWOOD, W. M., and P. H. STRUTHERS. 1928. Carp control studies in Oneida Lake. In: A Biological Survey of the Oswego River System, N.Y.S. Cons. Dept.:67-83.
- STEELE, R. G. D., and J. H. TORRIE. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Co., New York.
- TRAUTMAN, M. B. 1957. The Fishes of Ohio. Ohio State Univ. Press, Columbus.

LEVELS OF PCB AND TRACE METALS IN WATERFOWL IN NEW YORK STATE¹

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ABSTRACT

Selected tissues of seven species of waterfowl were analyzed for the presence of polychlorinated biphenyls (PCB) and trace metals. The greater scaup, white-winged scoter and bufflehead were species in whose tissues PCB was consistently found. Values above the detectable limits were obtained infrequently when tissues were analyzed for cadmium, beryllium and arsenic. Lead and mercury were present in many specimens whose diet included both aquatic and animal life. Results indicate that periodic and more extensive sampling would be useful.

While many migratory waterfowl are taken each year by hunting, it has been suggested that more fall victim to technological pollution. PCB's and/or trace metals have often been implicated as toxicological agents in the die-off of a number of waterfowl and other water birds. Hays and Risebrough (1972) reported toxicologically significant concentrations of PCB in terns, while Zitko and Choi (1972) and Bjerk and Holt (1971) detected PCB and p,p'-DDE residues in various other marine birds. Peakall and Lincer (1970) indicated the ubiquity of PCB in the environment. Tong et al. (1972) surveyed the concentration of selected trace metals in fish in New York State and concluded that at that time there was no hazard to the consumer. Johnson et al. (1971) found all pesticide and mercury levels in migrating duck populations in Iowa to be within the tolerances established by the U.S. Food and Drug Administration for fish, except for two samples in which the mercury level was above 0.5 microgram per gram.

This paper presents data on the levels of PCB and trace metals in liver, muscle and brain tissues from specimens of seven species of waterfowl collected in New York State and submitted by wildlife managers and the public for determination of the cause of death. The necropsies

¹ The authors acknowledge the invaluable assistance of Janis Barron and Dianne Gould in determining PCB levels by thin-layer chromatography, of John Snow in trace metal analysis and of Cheryl Houk in establishing the presence of Aroclor 1254 and chlordane by gas chromatography in many of the tissue samples.

were performed by the wildlife pathology unit of the State Department of Environmental Conservation at the Wildlife Research Laboratory at Delmar. All the specimens were moribund or dead, and, while natural events caused the death of some, others appeared to manifest conditions symptomatic of toxication. The findings indicate that PCB and/or trace metals were not responsible for death in the cases reported here. However, the findings do indicate some pollution of the coastal and marine waterways of the State.

MATERIALS AND METHODS

PCB was extracted from tissues by the method of Richardson et al. (1971) and was assayed by thin-layer chromatography following the modified method of Bush and Lo (1973). The limit of detection by this method is 0.5 microgram per gram; the precision is ± 10 per cent. G1500 silica gel acid-fast plates (Schleicher and Shuell, Keene, N.H. 03431) were spotted with samples and standards and were developed in nano-grade hexane (Mallinckrodt Chemical Works, St. Louis, Mo. 63160). Subsequently, the plates were sprayed with silver nitrate dissolved in water and glycerol and then irradiated for 15 minutes with shortwave ultraviolet light in a Cromato-Vue cabinet (Ultraviolet Products, San Gabriel, Calif. 91778). Spot densities were measured on a Vis-UV Chromatogram Analyzer (Farrand Optical Co., Mt. Vernon, N.Y. 11151) using the wide slit. The recovery for PCB-spiked tissues was at least 95 per cent at 10 micrograms per gram.

For cadmium, beryllium, arsenic and mercury analyses, tissues were first digested according to the method of Hatch and Ott (1968). For lead analysis, tissues were homogenized in an Omni-mixer homogenizer (Ivan Sorvall, Inc., Newton, Conn. 06470). Detection and quantification of cadmium, beryllium and mercury levels in tissue digests were done using a Varian Techtron AA5 Spectrophotometer (Varian Associates, Palo Alto, Calif. 94303). Arsenic was determined by the silver diethyldithiocarbonate method after arsine generation (American Public Health Association, 1971, p. 62) using a Bechman DU Spectrophotometer at 535 millimicrons (Bechman Instruments, Fullerton, Calif. 92634). Lead in tissue homogenates was detected by atomic absorption spectrophotometry using procedures developed by the Analytical Chemistry Section of the Division of Laboratories and Research of the New York State Department of Health (Aldous et al., 1973).

The trace-metal detection limits in tissue homogenates, in micrograms per gram, were as follows: cadmium, 2; lead, 2; beryllium, 1; arsenic, 0.4; and mercury, 0.016. Recovery percentages for spiked tissues were: cadmium, 84; lead, 80; beryllium, 91; arsenic, 87; and mercury, 76. In some instances there was a lack of sufficient tissues for all the planned analyses.

RESULTS AND DISCUSSION

The specimens analyzed were from 18 greater scaup (*Aythya marila nearctica*), eight white-winged scoters (*Melanitta deglandi*), five buffleheads (*Bucephala albeola*), six mallards (*Anas platyrhynchos*), seven black ducks (*Anas rubripes*), six canvasbacks (*Aythya valisineria*) and 10 Canada geese (*Branta canadensis*). Figure 1 indicates where the specimens were collected, and Table 1 lists the species studied from each area. While sampling was not statewide, two of the major migration corridors for migratory waterfowl over New York State, as described by Bellrose (1968), were represented.

Table 2 summarizes the levels of PCB and trace metals in the available tissue specimens from each species; blanks indicate lack of sufficient tissue for analysis. The detection limits are conservative and were the best possible at the time using atomic absorption analysis. The sensitivity achieved by Tong et al. (1972) resulted from avoiding chemical digestion and employing mass spectrometric analysis.

Although lack of sufficient tissues precluded a complete profiling for

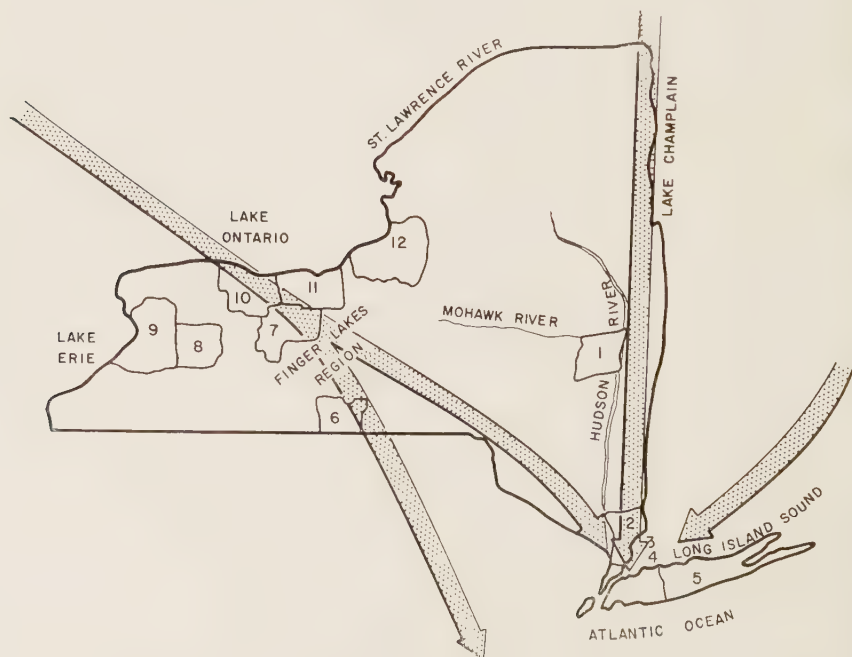


Figure 1. Migration corridors and location of areas in New York where the waterfowl specimens analyzed were collected. Numbers are cited in Table 1 with respect to the distribution of the specimens of each species

TABLE 1. GEOGRAPHIC DISTRIBUTION OF WATERFOWL SPECIMENS ANALYZED FROM NEW YORK

Map No.*	County	Species and number of specimens
1	Albany	Canada goose (2)
2	Westchester§	mallard (1)
3	Westchester†	greater scaup (7)
4	undetermined‡	bufflehead (5)
5	Suffolk	greater scaup (8) mallard (1) black duck (4) Canada goose (1)
6	Chemung	Canada goose (1)
7	Ontario	greater scaup (1) black duck (3) canvasback (6)
8	Wyoming	mallard (2)
9	Erie	mallard (1)
10	Monroe	white-winged scoter (1)
11	Wayne	greater scaup (2) mallard (1)
12	Oswego	white-winged scoter (7) Canada goose (1)

* See Figure 1.

§ Interior.

† Shore of Long Island Sound.

‡ Long Island Sound.

all the specimens, the data obtained did indicate differences in levels of contamination between species. While the time spent by each bird in the area where it was collected is unknown, the levels of PCB and trace metals found in some of the birds that used coastal or major inland waterways suggest the possible pollution of these waters. In no case, however, was the level of PCB or trace metals considered to have been the direct cause of death.

GREATER SCAUP (*Aythya marila nearctica*)

Measurable levels of PCB were found in most of the available tissues of all specimens of greater scaup, a species that prefers large bodies of water (e.g., Lake Ontario, Long Island Sound, Great South Bay) during migration. The analytical data strongly suggest PCB contamination of these waters and the aquatic life on which the ducks feed. Since scaups are hunted for food and since 27 per cent of the samples analyzed con-

Bufflehead													
4-M	§	0.7	..	§§§§§	..	§§§§§	..	§§§§§	..	..	0.110	§	0.083
4-F	§	0.5	..	§§§§§	..	§§§§§	..	§§§§§	..	..	§	§	..
4-F	§	1.2	0.6	..	..	..	..	..	..	..	0.099	..	..
4-M	1.0	1.4	0.8	2	..	..	..	..	..	..	§	0.090	..
Mallard													
5-M	§	0.9	..	§§§§§	..	§§§§§	..	§§§§§	..	..	0.087	0.142	..
11-F	§	..	..	§§§§§	..	§§§§§	..	§§§§§	..	..	0.119	0.109	..
2-M	§	1.6	0.5	2.77	..	3.96	..	..	..	..	0.216	§	..
8-M	5.6	1.6	2.6	3.07	..	3.98	..	..	..	..	0.033	0.029	..
8-M	1.2	6.5	1.3	3.88	..	..	..	..	..	..	0.101	0.033	..
9-M	0.5	§	..	§	..	3.90	..	..	..	..	0.039	0.478	..
Black duck													
5-M	§	2.3	§	§§§§§	..	5.76	..	..	..	..	0.284	0.092	..
5-M	§	..	..	§§§§§	..	6.96	..	..	..	..	0.031	0.08 ^a	..
5-F	0.5	..	..	§§§§§	..	§	..	..	..	..	§	§	..
5-M	4.3	2.9	1.3	..	..	2.0	..	..	..	..	0.152	§§§§§	..
7-F	§	§	§	2.0	..	§§§§§	..	..	..	..	0.030	§§§§§	..
7-M	§	§	1.1	7.01	..	§§§§§	..	..	..	..	§§§§§	§§§§§	..
Canvasback													
7-M	§	..	..	§§§§§	..	12.6	..	..	..	..	..	§	..
7-M	16.1	2.8	10.2	..	..	12.6	..	..	..	..	§§§§§	0.048	..
7-M	1.4	0.6	1.0	4	..	..	..	..	..	..	§§§§§	0.039	..
7-M	§	§	§	..	..	..	..	..	..	..	0.047	§§§	0.047

tained a greater level than 5 micrograms per gram which is the legal limit for poultry products (U.S. Food and Drug Administration, 1972), surveys of this species on a regular basis would be desirable. The level found approaches that which has been shown to cause chick deformities and embryonic death in domestic fowl (Tumasonis et al., 1973; Bush et al., 1974). All the greater scaup had died from gunshot wounds.

WHITE-WINGED SCOTER (*Melanitta deglandi*)

White-winged scoters are very similar in their feeding and migratory habits to the greater scaup. They are primarily coastal during migration, although the specimens presented for analysis were collected from inland waters. All the specimens had measurable levels of PCB. Because of the similarity in feeding and habitat, data for the scoters and scaup may be combined to establish the presence of PCB contamination in the waters that are their environment. The trace-metal levels recorded suggest no significant toxicological influence. One white-winged scoter from Monroe County died from salmonellosis, while the seven from Oswego County died from an enteritis caused by massive trematode infestations.

BUFFLEHEAD (*Bucephala albeola*)

Buffleheads move between fresh and salt water bodies; the specimens presented for analysis were collected from Long Island Sound and vicinity. All died from gunshot wounds; however, none of the samples analyzed was contaminated with lead pellets. Aquatic animals are their major food and hence the main route of PCB accumulation. PCB levels were low, and the trace-metal levels should have presented no toxicological difficulties.

MALLARD (*Anas platyrhynchos*)

Mallards were collected mostly from the western counties of the State. The low PCB levels, the presence of lead and the omnipresence of mercury in the tissues analyzed indicate contamination of aquatic plants and animals in the waters in which this species feeds. The specimens from Westchester and Wyoming Counties died from aspergillosis, whereas those from Suffolk, Erie and Wayne Counties died from botulism.

BLACK DUCK (*Anas rubripes*)

Low PCB levels were detected in a single tissue from each of three black ducks and in three tissues from a fourth specimen. By contrast, lead and mercury were found relatively frequently, suggesting that the feeding habits of this species differ from those of mallards and scaup. All the black ducks died from botulism.

CANVASBACK (*Aythya valisineria*)

All the canvasbacks were collected from Canandaigua Lake in Ontario County. Two of the six specimens had PCB in their liver, muscle and brain tissues. One of these two had a cadmium level of 4 micrograms per gram in liver and brain tissue, while the other had a lead level of 12.6 micrograms per gram in these tissues. These two birds may have been migrants from highly polluted areas. Two of the canvasbacks died from entanglement in nylon fishing line, two from salmonellosis, one from aspergillosis and one from malnutrition. The one thought to have died from malnutrition showed 12.6 micrograms per gram of lead in the liver and brain and had the highest PCB level of all the canvasbacks analyzed. No lead shot was found in the gizzard of this bird, but the lead level present probably contributed to its death.

CANADA GOOSE (*Branta canadensis*)

No Canada geese showed quantifiable levels of PCB or trace metals, except for one with cadmium in muscle tissue and two with mercury in liver tissue. The migratory movement of Canada geese over New York State and their feeding habits (they are primarily herbivorous) apparently preclude the accumulation of PCB to any detectable degree. Trace-metal accumulation, especially of lead, could occur as a result of ingesting lead pellets and contaminated grain; but no evidence of such accumulation was found. Six of the specimens died from being struck by lightning, two were killed by dogs, one died from aspergillosis, and one died from botulism.

The scattered lead levels found in several of the duck tissues analyzed indicate that lead contamination may be of significance, especially since it was found at high levels in half the counties sampled, as reflected in the mallards and black ducks. This limited survey indicates that periodic and more extensive sampling for possible PCB and lead contamination in scaup, buffleheads, mallards and black ducks is desirable.

LITERATURE CITED

- AMERICAN PUBLIC HEALTH ASSOCIATION. 1971. Standard Methods For the Examination of Water and Waste Water, 13th ed.
- ALDOUS, K. M., D. C. MITCHELL and F. J. RYAN. 1973. A computer-controlled atomic absorption spectrometer for measurement of transient atom population. *Anal. Chem.* 45:1990.
- BELLROSE, F. C. 1968. Waterfowl migration corridors east of Rocky Mountains in United States. *Illinois Nat. Hist. Surv., Biol. Note* 61.
- BJERK, J. E., and G. HOLT. 1971. Residues of DDE and PCB in eggs from herring gull (*Larus argentatus*) and common gull (*Larus campestris*) in Norway. *Acta Vet. Scand.* 12(3):429-441.
- BUSH, B., and FA-CHUN LO. 1973. Thin-layer chromatography for quantitative polychlorinated biphenyl analysis. *Jour. Chromatog.* 7:377.

- BUSH, B., C. F. TUMASONIS and F. D. BAKER. 1974. Toxicity and persistence of PCB homologs and osomers in the avian system. *Arch. Environ. Contam. Toxicol.* 2(3):195-212.
- HATCH, W. R., and W. L. OTT. 1968. Determination of submicrogram quantities of mercury by atomic absorption spectrophotometry. *Anal. Chem.* 40(14): 2085-2087.
- HAYS, H., and R. W. RISEBROUGH. 1972. Pollutant concentrations in abnormal young terns from Long Island Sound. *Auk* 89:19-35.
- JOHNSON, L. G., R. L. MORRIS and R. BISHOP. 1971. Pesticide and mercury levels in migrating duck populations. *Bull. Environ. Contam. Toxicol.* 6(6): 513-516.
- PEAKALL, D. B., and J. L. LINGER. 1970. Polychlorinated biphenyls, another long-life widespread chemical in the environment. *Bioscience* 20(17):958-964.
- RICHARDSON, A., J. ROBINSON, A. N. CRABTREE and M. K. BALDWIN. 1971. Residues of polychlorobiphenyls in biological samples. *Pesticide Monit. Jour.* 4:169.
- TONG, S. C., W. H. GUTENMANN, D. J. LISK, G. E. BURDICK and E. J. HARRIS. 1972. Trace metals in New York State fish. *N.Y. Fish and Game Jour.* 19(2): 123-131.
- TUMASONIS, C. F., B. BUSH and F. D. BAKER. 1973. PCB levels in egg yolks associated with embryonic mortality and deformity of hatched chicks. *Arch. Environ. Contam. Toxicol.* 1(4):312-324.
- U.S. FOOD AND DRUG ADMINISTRATION. 1972. Temporary tolerances for polychlorinated biphenyls. *Federal Register* 37:5705. (March 18, 1972)
- ZITKO, W., and P. M. K. CHOI. 1972. PCB and p,p'-DDE in eggs of cormorants, gulls, and ducks from the Bay of Fundy, Canada. *Bull. Environ. Contam. Toxicol.* 7(1):63-64.

SOME IMPLICATIONS OF COMMUNAL DENNING AND PUP ADOPTION AMONG RED FOXES IN NEW YORK¹

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ABSTRACT

Instances of communal denning and the adoption of orphaned pups were observed among red foxes in Cayuga County, New York. Though this behavior may have had survival value in earlier times, it may be detrimental when contagious zoonotic diseases, such as sarcoptic mange or rabies, are present.

Sheldon (1950) described seven separate instances of communal denning of red foxes (*Vulpes fulva*) in central New York. He also noted that D. F. Switzenberg had reported three litters of 10, one litter of 14 and one litter of 15 red fox pups in Michigan which he interpreted as evidence of communal denning. Pils and Martin (1974) described a communal den in Wisconsin from which a radio-equipped female red fox was pulled and killed by dogs. They found that the pups left by the dead vixen were still alive near the den site after more than a month and had apparently been cared for by the other adult red foxes at the den. Burrows (1968) found that female European red foxes (*Vulpes vulpes*) did not appear to defend territories against other foxes, and he implied that male foxes defend territories primarily during the mating season. Pils and Martin (1974) suggested that communal denning serves to insure the survival of fox pups if the parents are killed. A. B. Sargent (personal communication) reported finding an occasional red fox pup among untaged litters dug from dens in North Dakota.

The adoption of pups and the acceptance of visitors or refugees are analogous to communal denning. Observations during a study of foxes in Cayuga County (N.Y.) suggest that den sharing among fox families may be stress-caused and disadvantageous to red foxes in New York under present conditions.

On April 21, 1973, four 4- to 5-week-old red fox pups were received from a farm family who had dug them from a den and killed the vixen in the process. These orphaned pups were immediately ear tagged and

¹The authors wish to extend their thanks and appreciation to their colleagues Howard G. Parish, Elmer T. Davies, Stewart R. Van Wie, Cecil Barrett and Stanley A. Butkas who did most of the field work which produced the data reported here.

put into another den with a vixen and two 6- to 7-week-old pups that were tagged at the same time. On May 10, on a farm half a mile from the latter den, seven red fox pups were taken from four separate woodchuck-burrow systems scattered over a lens-shaped area 180 feet long. In each of three of these burrow systems, one of the tagged orphan pups was found in the same cavity or tunnel with a larger pup. The fourth tagged orphan was caught after it had left the remaining burrow system and may have been following an unseen larger pup. One of the larger pups was one of the two that had also been tagged on April 21 at the second den, the other two larger pups were untagged, indicating that the surrogate mother had had at least four pups of her own when the orphans were presented to her. The grouping of the pups of both sizes and their good physical condition was evidence that the vixen was definitely caring for all pups at her den.

On April 24, 1974, a den involving seven woodchuck holes in four groups was excavated in a woodlot. Of the 13 red fox pups located, only 12 could be captured for marking. Six of the captured pups had been dug out of another den 0.3 mile away on April 19 and were already tagged. Digging and tagging activities had probably stressed the vixen who had moved her litter in with another litter of seven. Most of the pups, six marked and five unmarked, were found in the same interconnected burrow system. The other two were found in outlying holes only because they were barking at the diggers. An adult barked from nearby cover for nearly half an hour as the crew finished at dusk.

Another case of stress-induced communal denning occurred in early April 1974. A woodchuck hunter found an occupied red fox den on a large hill and shot two adults. The hunter saw pups but did not shoot them. Several days later, he shot another adult red fox, also with pups, at a different den on the same hill about 300 yards from the one where he had killed the first two foxes, and the following evening he killed a fourth fox at this site. Apparently, the pups of both litters had been collected at the second site by the adults shot last. Objecting to the presence of what he thought were at least 10 fox pups, the landowner contacted Howard Parish, field supervisor of the study in Cayuga County, and asked him to remove them. A total of eight healthy appearing pups were taken with small traps. Seven were 7 to 8 weeks old, and one was about 5 weeks old. The carcasses of both adult foxes at the second den, which had been left where they fell, had been eaten in the manner that red fox pups usually consume larger prey. The carcasses were partially skinned and eviscerated, much of the hind quarters had been consumed.

A finding at the Skoff farm on April 18, 1974 indicates the extent to which adult red foxes may go to gather abandoned pups. When a litter of six 6- to 7-week-old red fox pups was dug from a den, the body of a

4- to 5-week-old red fox pup was found among the debris of the nest cavity. This pup had been dead for at least one day and possibly longer, but it could not have been in the den for as long as 2 weeks, the difference between its age and that of the live pups. Because the den was shallow, its temperature was so high that many food items were rotting, but the body of the dead pup was relatively undecomposed. This pup must have been from a different litter. Its skull had been flattened, suggesting a road mortality that the vixen may have found on a nearby road. It is doubtful that it was brought to the den as a food item because there was no evidence of chewing or mutilation other than the crushed skull.

Pils and Martin (1974) conjectured that communal denning "allows the alternate female to nurse or care for the pups until they are ready to leave the den sites permanently". However, in some situations, the gregarious tendencies of red foxes may be disadvantageous. On May 10, 1974, a dead 8- to 9-week-old red fox pup was found in Columbia County (N.Y.) The pup had died of acute sarcoptic mange which was confirmed microscopically. The finder reported seeing live pups where the dead one was found. Project personnel visited the site and located three cubs, all with severe infestations of sarcoptic mange, that had been staying under a pile of rotten elm limbs. Evidence of recent use (fox droppings and decaying bodies of small mammals) was found around five separate woodchuck-burrow systems in an arc several hundred feet from the elm limb pile. At autopsy, the stomach of the dead pup was found to contain bones, skin, hair and maggots, indicating that the pups had attempted to subsist on the litter found around the woodchuck holes. The pups had probably been abandoned by a vixen which may have died or become moribund from sarcoptic mange. Stone et al. (1972) found that foxes succumb to sarcoptic mange in from 2 to 4 months, depending upon age. A local resident reported seeing a normal-looking adult red fox and a "dark" pup in the vicinity of the elm limb pile several days before the dead pup was found. It is highly unlikely that this adult was one of the parents of the mangy litter, but it is possible that it was "adopting" the sick pup as the vixen on the Skoff farm had "adoped" the pup with the crushed skull. The dead pup, had it not been found by a man, might also have been picked up by a healthy vixen with a litter. In either case, such an act would have been fatal to the surrogate mother and her litter.

It seems possible, in the light of these incidents, that even a rabid red fox pup may be attractive to a vixen with a litter. The willingness of vixens to share their dens with other vixens and pups may be common, as Pils and Martin (1974) suggested. These observations help to explain how red foxes, that have been observed according to Sargent (1972) to occupy "well defined, non-overlapping, contiguous territories", can be

virtually wiped out by mange in a locality or support a rabies outbreak. The usual red fox family consists of from 7 to 10 animals (counting both parents) and remains in direct or indirect contact for 4 to 6 months. This family cohesiveness results in local grouping or concentration. Communal denning and adoptions intensify local concentrations. The usual concentrations are in themselves conducive to the spread of parasites or contagious diseases, but the addition of orphaned, diseased-infected pups makes the situation still worse.

LITERATURE CITED

- BURROWS, R. 1968. Wild Fox. Taplinger Publishing Co., New York.
- PILS, C. M., and M. A. MARTIN. 1974. Dog attack on communal fox den in Wisconsin. Jour. Wildl. Mgt. 38(2):359-360.
- SARGENT, A. B. 1972. Red fox spatial characteristics in relation to waterfowl predation. Jour. Wildl. Mgt. 36(2):225-247.
- SHELDON, W. G. 1950. Denning habits and home range of red foxes in New York State. Jour. Wildl. Mgt. 14(1):33-42.
- STONE, W. B., E. PARKS, B. WEBER and F. J. PARKS. 1972. Experimental transfer of sarcoptic mange from red foxes and wild canids to captive wildlife and domestic animals. N.Y. Fish and Game Jour. 19(1):1-11.

GENERAL NOTES

LIGHT PENETRATION IN CANADICE LAKE

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The data reported here were gathered on Canadice Lake in Ontario County (N.Y.) in June and July of 1974. Light intensity was measured at 1-meter intervals from the surface to a depth of 8 meters (after Westlake, 1965) using a Whitney underwater light meter. White light was determined directly. Light at 430, 460 and 670 nanometers was determined by covering the photocell with Kodak 47B, 46, and 9 and 31 (in series) gelatin filters (Eastman Kodak Co., 1970), respectively, as described by Marcus (1975). The data are summarized in Table 1.

TABLE 1. RELATIVE LIGHT INTENSITIES AT DIFFERENT DEPTHS IN CANADICE LAKE*

Depth (meters)	Type of light§			
	Wavelength (nanometers)†			White (4)
	430 (3)	460 (3)	670 (1)	
0	100.0	100.0	100.0	100.0
1	50.0	52.0	30.0	76.0
2	30.0	36.0	20.0	50.0
3	18.0	27.0	12.0	40.0
4	13.5	18.0	7.5	29.0
5	10.0	13.0	4.9	22.0
6	8.0	9.0	3.1	16.0
7	6.5	8.0	2.0	12.0
8	5.4	7.1	1.4	10.0

* Values represent percentage of light.

§ Figures in parentheses represent number of observations in each case.

† Determined by use of filters as described in text.

Mean secchi disc transparency, based on four separate observations, was found to extend to 5.9 meters. Water temperature, based on four observations using a Whitney underwater thermal probe, was found to be a fairly uniform 21° C. from the surface to a depth of 7 meters and to decrease to 16° C. at 8 meters.

Strickland (1958) reported that the greatest penetration in clear lakes is made by light at around 480 nanometers, while the least penetration is made by visible light of long wavelength. Based on his description and the data in Table 1, it is concluded that the water of the epilimnion of Canadice Lake was fairly clear.

LITERATURE CITED

- EASTMAN KODAK CO. 1970. Kodak filters for scientific and technical uses. Kodak Tech. Publ. B-3.
- MARCUS, B. A. 1975. A simple and inexpensive technique for determining colored light intensity under water. *Water Resources Res.* 11(3):491-492.
- STRICKLAND, J. D. H. 1958. Solar radiation penetrating the ocean. A review of requirements, data, and methods of measurement, with particular reference to productivity. *Jour. Fish. Res. Bd. Can.* 15:453-493.
- WESTLAKE, D. F. 1965. Some problems in the measurement of radiation underwater: a review. *Photochem. and Photobiol.* 4:849-868.

OCCURRENCE OF THE GILL PARASITE *ERGASILUS LABRACIS* ON STRIPED BASS, WHITE PERCH AND TOMCOD IN THE HUDSON RIVER¹

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During 1972 and 1973, parasitic cyclopoid copepods were frequently observed on gill filaments of striped bass (*Morone saxatilis*) and white perch (*Morone americana*) collected from the lower Hudson River in New York. Using Roberts' (1970) taxonomic key, periodic examination of specimens during the spring of 1973 revealed the presence of the gill parasite *Ergasilus labracis*. Of 20 specimens of each species collected in April, examination indicated infestations of 60 and 20 per cent for striped bass and white perch, respectively. Infested striped bass ranged from 1 year old (1972 year class) to a 6+-year-old specimen weighing 8.39 kilograms (18.5 pounds) and measuring 91.1 centimeters in total length. All specimens were collected from the Hudson River between Ossining (River Mile 30) and Peekskill (River Mile 43).

E. labracis with developed egg sacs were observed on three 1-year-old fish (two white perch and one striped bass) collected on March 6, 1973 at Verplanck (River Mile 42). The water temperature was 1.5° C. and the salinity was 3.5 ppt, with "flow ice" present. Smith (1949) reported *Ergasilus* with developed egg sacs in New Jersey as early as March 31.

On April 5, 1973, two tomcod (*Microgadus tomcod*) were collected from the Hudson River at Ossining. Examination showed both to be infested with *E. labracis*, with 37 of the parasites being detected on one fish.

Although *E. labracis* has been previously reported from striped bass (see Wilson, 1911), it has been found to have a localized distribution, being observed only as a parasite of striped bass on the Atlantic coast (Johnson and Rogers, 1973). It apparently has not been previously reported from white perch or tomcod, since it was not mentioned in the accounts of Smith (1949), Hoffman (1967), Howe (1971) or Johnson and Rogers (1973).

LITERATURE CITED

- HOFFMAN, G. 1967. Parasites of North American Freshwater Fishes. Univ. Calif. Press., Berkeley.
- HOWE, A. 1971. Biological investigation of Atlantic tomcod *Microgadus tomcod* (Walbaum), in the Weweantic River Estuary, Massachusetts, 1967. M.S. thesis, Univ. Mass. Library.
- JOHNSON, S., and W. ROGERS. 1973. Distribution of the genus *Ergasilus* in several Gulf of Mexico drainage basins. Auburn Univ. (Ala.) Agric. Exp. Sta., Bull. 445.
- ROBERTS, L. 1970. *Ergasilus* (Copepoda: Cyclopoida): revision and key to species in North America. Trans. Am. Microsc. Soc. 89(1):134-161.
- SMITH, R. 1949. Notes on *Ergasilus* parasites from the New Brunswick, New Jersey area, with a check list of all species and hosts east of the Mississippi River. Zoologica 34:127-132.
- WILSON, C. 1911. North American parasitic copepods belonging to the family Ergasilidae. Proc. U.S. Natl. Mus. 39:263-400.

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FAILURE OF ELK TO SURVIVE IN THE ADIRONDACKS

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According to records compiled by Bump (1941), a total of 332 elk (*Cervus canadensis*) were liberated in the Adirondack region between 1893 and 1906. The number released in any one locality, in any one year, varied from four to 51. The localities involved were: Forked Lake, Litchfield Park, Racquette Lake and the Whitney Preserve in Hamilton County; Nehasane Park in Herkimer County; Big Moose Lake in Hamilton and Herkimer Counties; Bay Pond Park, Paul Smiths and Saranac Inn in Franklin County; Harris Lake and Woodruff Pond in Essex County; and Lake George and Tongue Mountain in Warren County. In 1916, a carload (possibly 25 animals) were liberated in the "Adirondacks". And in 1932, six animals were liberated on the DeBar Mountain Game Refuge in Franklin County.

The 66 elk liberated on Nehasane Park in 1893 and 1894 came from Wyoming. Those liberated at Forked Lake came from a preserve in Massachusetts, and those at Bay Pond Park from a preserve in Connecticut. The ones released at Harris Lake, Woodruff Pond, Lake George and Tongue Mountain and the six liberated on the DeBar Mountain Game Refuge came from the Blue Mountain Preserve in New Hampshire. It is believed that the sources of the others were similar and that all were wild-trapped. It is also believed that they were all, or very nearly all, adults.

The early liberations appeared for a time to be successful. Elk were frequently reported, and in 1906 they were estimated to number 350 (New York Forest, Fish and Game Commission, 1907). But, ultimately, they failed to establish a population. The exact cause of their disappearance was never known, although in most instances some animals survived for several years. There are authenticated records of an elk being killed by a woodchopper near Santa Clara (Franklin County) in 1933 and of a bull elk being shot at the North Woods Club near Minerva (Essex County) on October 30, 1946. The six elk, all adults, released on the DeBar Mountain Game Refuge in 1932 were known to have increased to 14 by 1937 and to about 20 by 1939. An unknown number were still present in 1941 when they were living partly on the refuge and partly on an adjoining privately-owned preserve (Len Merrill's) which in the early 1940's was sold to a hunting club with a limited membership. However, within a few years, the elk had disappeared. The disappearance was gradual. George Buckley, the refuge caretaker, told the author that he continued to see four or five elk until 1945 when the refuge was opened to deer hunting for three days. He also said that a hunter was reported to have killed a cow elk on Roaring Brook (east side of Meacham Lake) and that an old bull was killed on the west side of DeBar Pond in the fall of 1945. He said that the last time he saw an elk in the vicinity of the refuge was in the winter of 1952-53 when they were cutting blowdown and a cow elk stayed on East Mountain all winter. Buckley said further that, the next summer while he was trapping nuisance beaver at Marcy Dam in Essex County, a cow elk went up the trail ahead of him. There is no authenticated record of a wild elk in the Adirondacks since 1953.

Although the elk liberated on the DeBar refuge increased to about 20, when five to eight calves were probably being produced, they failed to establish a population and disappeared. Those liberated earlier may have followed a similar pattern; in any event, they, too, all disappeared. In all probability, poaching was a significant factor. However, recent studies (Anderson et al., 1966) have shown that the round worm *Pneumostrongylus tenuis*, which is carried by deer, may have been an additional cause of mortality among the liberated elk. This parasite is believed to be a major limiting factor to the survival of moose in the Adirondacks (Severinghaus and Jackson, 1970).

LITERATURE CITED

- ANDERSON, R. C., M. W. LANKESTER and I. R. STRELIN. 1966. Further experimental studies of *Pneumostromylus tenuis* in cervids. Can. Jour. Zool. 44(5):851-861.
- NEW YORK FOREST, FISH AND GAME COMMISSION. 1907. The elk. In: Annual Reports for 1904, 1905 and 1906:301-302.
- SEVERINGHAUS, C. W., and LAWRENCE W. JACKSON. 1970. Feasibility of stocking moose in the Adirondacks. N.Y. Fish and Game Jour. 17(1):18-32.

EXOTIC PSITTACINES IN NEW YORK STATE

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The status of the monk parakeet (*Myiopsitta monachus*) in New York State as a potential pest, competitor with native birds and introducer of disease has been discussed by Roscoe et al. (1973, 1974). Reports of other exotic psittacine birds found free-flying in the United States have prompted concern over their possible establishment.

The rose-ringed parakeet (*Psittacula krameri*) is a native of India, where its destructive feeding habits have earned it the wrath of the Hindus who traditionally hold animals in high esteem (Gardiner Bump, personal communication). The species has established colonies in Dade County, Florida (Owre, 1973) and Los Angeles, California (Hardy, 1973) and has been found overwintering in the New York metropolitan area (Bull, 1973). Investigations by the authors from June 1973 to August 1974 revealed a flock of approximately 30 (23 counted in a single tree) in the vicinity of the Bronx Botanical Gardens and Veterans Hospital in the Bronx, only two of which were females. One of these females and six males were live trapped. Also, along the south shore of Long Island personnel of the State Department of Environmental Conservation shot or captured 15 rose-ringed parakeets from mixed flocks containing other species of parrots. A pair were observed entering and leaving a tree cavity at Brightwaters on Long Island and the female was trapped, but the cavity was inaccessible so that nesting could not be confirmed. Of 22 specimens examined, 10 had frostbitten toes, indicating that they had overwintered as free-flying birds. That only three of these birds were females probably reflected the preference of pet owners for the more colorful males. In this species, unlike the monk parakeet in which the sexes are similar (Roscoe et al., 1973), sexual dimorphism also results in a higher proportion of males being imported which may mitigate against its becoming established.

Several other species of psittacine birds have been reported in the wild in New York (Bull, 1973). The authors shot or trapped a blue-fronted Amazon parrot (*Amazona aestive*), two Mexican red heads (*Amazona viridigenalis*), a canary-winged parakeet (*Brotogeris versicolurus*), two black-headed parakeets (*Nandayus nenday*) and a half moon conure (*Aratinga canicularis*) along the south shore of Long Island. These birds were present in mixed flocks with the rose-ringed parakeets. The blue-fronted Amazon parrot, both Mexican red heads and both black-hooded parakeets had frostbitten toes. Also, two maroon-tailed conures (*Pyrhura melanura*) were shot near Smithtown on Long Island when a farmer reported them feeding on his corn, and a black-hooded parakeet was shot near Bellport when it, too, was discovered feeding in a cornfield.

The destructiveness of the monk parakeet to agricultural crops, orchards and ornamental shrubs has been pointed out by Bump (1971) and Roscoe et al. (1973, 1974). Less is known about the other species in this respect, but it seems likely that many of them may have similar habits. Also, exotic Newcastle disease and ornithosis (psittacosis) are carried by parrots and parakeets. Nine positive isolations of exotic Newcastle disease were made from pet parakeets in California (Hardy, 1973). However, several of the parrots and parakeets taken in the present study were examined and found to be negative for ornithosis. The flocking habits of these species provide a greater opportunity for disease to spread than is the case among less gregarious birds. This potential is also heightened by their tendency to form mixed flocks.

Unlike the monk parakeet, virtually all the other psittacines noted here are from tropical climates in Central America, northern South America or India. However, it is testimony of their adaptability and hardiness that they have been able to survive in our temperate climate. It seems likely that many could become established as wild populations in some localities. For any exotic species of parrot or parakeet to become so established in New York would be undesirable, and measures to prevent it have been undertaken. Also, legislation enacted in 1974 classifies all free-living psittacine birds as unprotected.

LITERATURE CITED

- BULL, J. 1973. Exotic birds in the New York City area. *Wilson Bull.* 85(4): 501-505.
- BUMP, G. 1971. The South American monk, quaker, or gray-headed parakeet. U.S. Fish and Wildl. Serv., Wildl. Leaflet 496.
- HARDY, J. H. 1973. Feral exotic birds in southern California. *Wilson Bull.* 85(4):506-512.
- OWRE, O. T. 1973. A consideration of the exotic avifauna of southeastern Florida. *Wilson Bull.* 85(4):491-500.
- ROSCOE, D. E., J. B. ZEH and W. B. STONE. 1974. Monk parakeets—unwanted immigrants. *Animal Kingdom* 77(1):20-24.
- ROSCOE, D. E., J. B. ZEH, W. B. STONE, L. P. BROWN and J. L. RENKAVINSKY. 1973. Observations on the monk parakeet in New York State. *N.Y. Fish and Game Jour.* 20(2):170-173.

Errata

In Table 7 (page 142) of the paper "Analysis of the First Deer Harvest on the Cary Estate in Dutchess County, New York" by Jeffrey A. Davis (*New York Fish and Game Jour.* 22(2):128-147), the headings "male" and "female" of the two columns giving the number of adult deer should be reversed. Also, in Table 4 (page 140), the weights are in pounds.